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HP 8163A/4A/6A Lightwave Series Mainframes

# HP 8163A Lightwave Multimeter, HP 8164A Lightwave Measurement System, & HP 8166A Lightwave Multichannel System User's Guide

Third Edition

## Notices



### Subject Matter

The information in this document is subject to change without notice.

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### Printing History

New editions are complete revisions of the guide reflecting alterations in the functionality of the instrument. Updates are occasionally made to the guide between editions. The date on the title page changes when an updated guide is published. To find out the current revision of the guide, or to purchase an updated guide, contact your Hewlett-Packard representative.

Control Serial Number: First Edition applies directly to all instruments.

### Warranty

This Hewlett-Packard instrument product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, HP will, at its option, either repair or replace products that prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by HP. Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

HP warrants that its software and firmware designated by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument, software, or firmware will be uninterrupted or error free.

### Limitation of Warranty

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer. Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

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The remedies provided herein are Buyer's sole and exclusive remedies. Hewlett-Packard shall not be liable for any direct, indirect, special, incidental, or consequential damages whether based on contract, tort, or any other legal theory.

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Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products. For any assistance contact your nearest Hewlett-Packard Sales and Service Office.

### Certification

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory.

Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology, NIST (formerly the United States National Bureau of Standards, NBS) to the extent allowed by the Institutes's calibration facility, and to the calibration facilities of other International Standards Organization members.

### ISO 9001 Certification

Produced to ISO 9001 international quality system standard as part of our objective of continually increasing customer satisfaction through improved process control.

Third Edition:
08164-91011 E0100

First Edition:
E0599: May 1999

Second Edition:
E1299: December 1999

Third Edition:
E0100: January 2000

# Safety Considerations

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements.

**General** This is a Safety Class 1 instrument (provided with terminal for protective earthing) and has been manufactured and tested according to international safety standards.

Before operation, you should review the instrument and manual for safety markings and instructions. You must follow these to ensure safe operation and to maintain the instrument in safe condition.

Some HP 8164A circuits and some HP 8166A circuits are powered whenever the instrument is connected to the AC power source. To disconnect from the line power, disconnect the power cord either at the rear power inlet or at the AC line power source (receptacle). One of these must always be accessible. If the instrument is in a cabinet, it must be disconnected from the line power by the system's line power switch.

**WARNING**

To avoid hazardous electrical shock, do not perform electrical tests when there are signs of shipping damage to any portion of the outer enclosure (covers, panels, and so on).

## Line Power Requirements

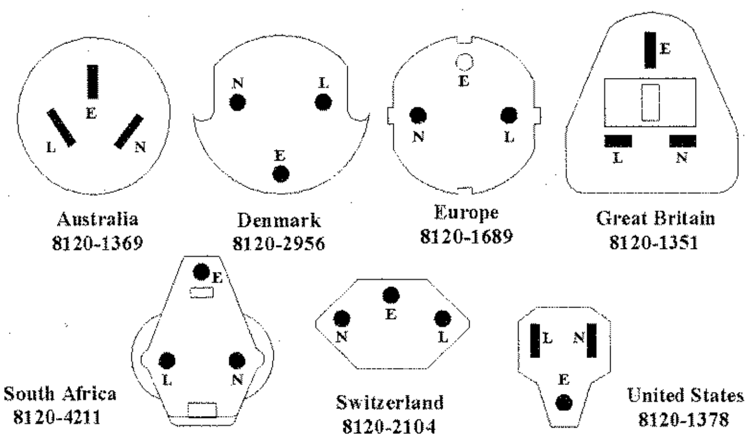
The HP 8163A Lightwave Multimeter can operate from the single-phase AC power source that supplies between 100 V and 240 V at a frequency in the range 50 to 60 Hz. The maximum power consumption is 120 VA with all options installed.

The HP 8164A Lightwave Measurement System can operate from any single-phase AC power source that supplies between 100 V and 240 V at a frequency in the range from 50 to 60 Hz. The maximum power consumption is 270 VA with all options installed.

The HP 8166A Lightwave Multi-Channel System can operate from any single-phase AC power source that supplies between 100 V and 240 V at a frequency in the range from 50 to 60 Hz. The maximum power consumption is 450 VA with all options installed.

## Line Power Cable

In accordance with international safety standards, the instrument has a three-wire power cable. When connected to an appropriate AC power receptacle, this cable earths the instrument cabinet. The type of power cable shipped with each instrument depends on the country of destination. Please refer to the figure below for the part numbers of available power cables.




**WARNING**

To avoid the possibility of injury or death, you must observe the following precautions before switching on the instrument.

If this instrument is to be energized via an autotransformer for voltage reduction, ensure that the Common terminal connects to the earth pole of the power source.

- Insert the power cable plug only into a socket outlet provided with a protective earth contact. Do not negate this protective action by the using an extension cord without a protective conductor.
- Before switching on the instrument, the protective earth terminal of the instrument must be connected to a protective conductor. You can do this by using the power cord supplied with the instrument.
- Do not interrupt the protective earth connection intentionally.

The following work must be carried out by a qualified electrician. All local electrical codes must be strictly observed. If the plug on the cable does not fit the power outlet, or if the cable is to be attached to a terminal block, cut the cable at the plug end and rewire it.

The color coding used in the cable depends on the cable supplied. If you are connecting a new plug, it should meet the local safety requirements and include the following features:

- Adequate load-carrying capacity (see table of specifications).
- Ground connection.
- Cable clamp.

## Operating Environment

**WARNING**

The HP 8163A Lightwave Multimeter, HP 8164A Lightwave Measurement System, and HP 8163A Lightwave Multichannel System are not designed for outdoor use. To prevent potential fire or shock hazard, do not expose the instrument to rain or other excessive moisture.

## Input/Output Signals

**CAUTION**

There are two input BNC connectors: the Remote Interlock Connector and the Trigger Input, see page 202. These are TTL inputs. A maximum of 5 V can be applied as an external voltage to either of these input connectors.

There is one output BNC connector: the Trigger Output, see page 202. This is a TTL output. Do not apply an external voltage to this connector.

# Additional Safety Requirements

**Operation - Before applying power** Comply with the installation section. Additionally, the following shall be observed:

- Do not remove instrument covers when operating.
- Before the instrument is switched on, all protective earth terminals, extension cords, auto-transformers and devices connected to it should be connected to a protective earth via a ground socket. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in serious personal injury.
- Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.
- There is no user-replaceable fuse in this instrument. The use of repaired fuses and the short-circuiting of fuseholders must be avoided.
- Adjustments described in the manual are performed with power supplied to the instrument while protective covers are removed. Be aware that energy at many points may, if contacted, result in personal injury.
- Any adjustments, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible, and when unavoidable, should be carried out only by a skilled person who is aware of the hazard involved. Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation is present. Do not replace components with power cable connected.
- Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

- Do not install substitute parts or perform any unauthorized modification to the instrument.
- Be aware that capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

## Safety Symbols



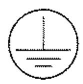
The apparatus will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect the apparatus against damage.



Caution, risk of electric shock.



Frame or chassis terminal.



Protective conductor terminal.



Hazardous laser radiation.



Magnetic fields may interfere with a pacemaker.

**WARNING**

The WARNING sign denotes a hazard. It calls attention to a procedure, practice or the like, which, if not correctly performed or adhered to, could result in injury or loss of life. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

**CAUTION**

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the equipment. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

# Initial Safety Information for Laser Source Modules

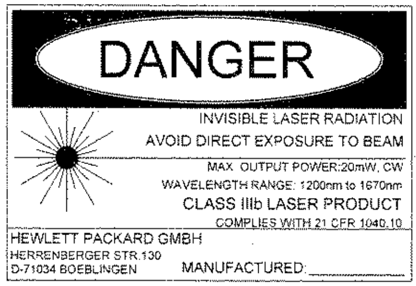
| | HP 81650A | HP 81651A | HP 81652A | HP 81654A |
|---|---|---|---|---|
| *Laser Type* | FP-Laser InGaAsP | FP-Laser InGaAsP | FP-Laser InGaAsP | FP-Laser InGaAsP |
| *Laser Class* | | | | |
| According to IEC 825 (Europe) | 1 | 1 | 1 | 1 |
| According to 21 CFR 1040.10 (Canada, Japan, USA) | I | I | I | I |
| Output Power | > 0 dBm | > 0 dBm | > 0 dBm | > 0 dBm |
| *Beam Diameter* | 9 µm | 9 µm | 9 µm | 9 µm |
| *Numerical Aperture* | 0.1 | 0.1 | 0.1 | 0.1 |
| *Wavelength (±15nm)* | 1310 nm | 1550 nm | 1550/1625 nm | 1310/1550 nm |

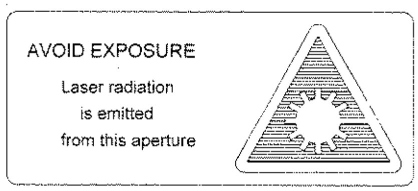
| | HP 81655A | HP 81656A | HP 81657A | HP 81661A |
|---|---|---|---|---|
| *Laser Type* | FP-Laser InGaAsP | FP-Laser InGaAsP | FP-Laser InGaAsP | DFB-Laser InGaAsP |
| *Laser Class* | | | | |
| According to IEC 825 (Europe) | 3A | 3A | 3A | 3A |
| According to 21 CFR 1040.10 (Canada, Japan, USA) | IIIb | IIIb | IIIb | IIIb |
| Output Power | > +13 dBm | > +13 dBm | > +13 dBm | > +10 dBm |
| *Beam Diameter* | 9 µm | 9 µm | 9 µm | 9 µm |
| *Numerical Aperture* | 0.1 | 0.1 | 0.1 | 0.1 |
| *Wavelength (±15nm)* | 1310 nm | 1550 nm | 1310/1550 nm | ITU Grid (C- and L-Band) |

# Initial Safety Information for Tunable Laser Source Modules

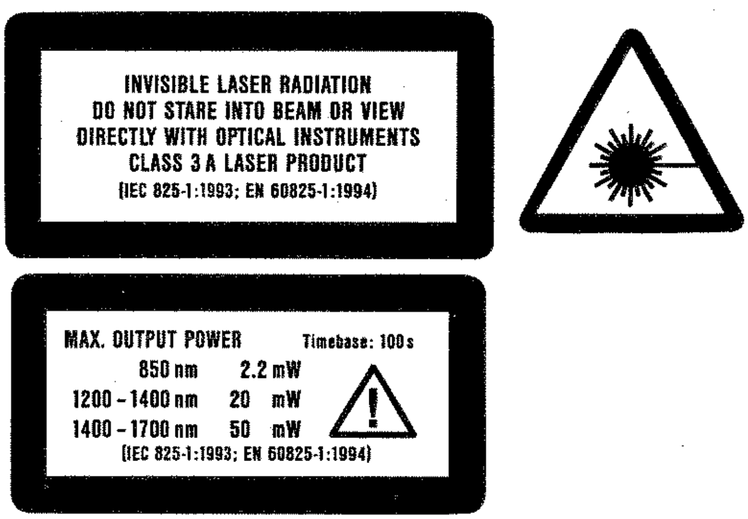
| | HP 81680A | HP 81682A | HP 81640A | HP 81689A |
|---|---|---|---|---|
| Laser Type | Fabry Perot-Laser In-GaAsP | Fabry Perot-Laser In-GaAsP | Fabry Perot-Laser In-GaAsP | Fabry Perot-Laser In-GaAsP |
| Laser Class | | | | |
| According to 21 CFR 1040.10 (USA) | IIIb | IIIb | IIIb | IIIb |
| Permissible Output Power (CW) | <20 mW | <20 mW | <20 mW | <20 mW |
| Beam Diameter | 9 µm | 9 µm | 9 µm | 9 µm |
| Numerical Aperture | 0.1 | 0.1 | 0.1 | 0.1 |
| Wavelength | 1200-1670 nm | 1200-1670 nm | 1200-1670 nm | 1200-1670 nm |
| Laser Class | | | | |
| According to IEC 825-1 (Non-USA) EN 60825-1 Europe | 3A | 3A | 3A | 3A |
| Permissible Output Power (CW) | <20 mW | <20 mW | <20 mW | <20 mW |
| Beam Diameter | 9 µm | 9 µm | 9 µm | 9 µm |
| Numerical Aperture | 0.1 | 0.1 | 0.1 | 0.1 |
| Wavelength | 1400-1670 nm | 1400-1670 nm | 1400-1670 nm | 1400-1670 nm |

### USA (HP 81655A-HP 81657A)



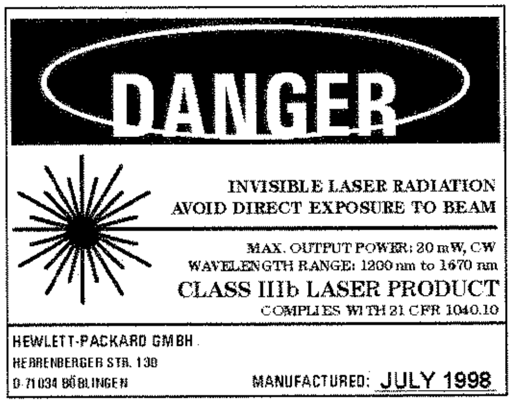



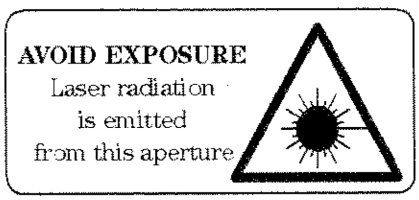

### Non-USA (HP 81655A-HP 81657A)



**USA (All Tunable Laser Source Modules HP 81640A/80A/82A/89A)**

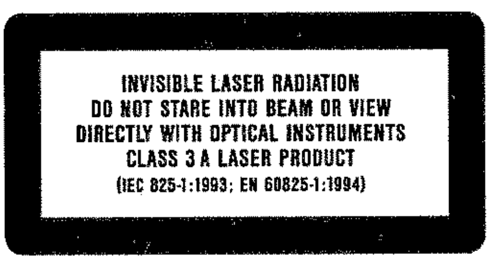
These laser safety warning labels are fixed on the outside of the HP 8164A Lightwave Measurement System before shipment.

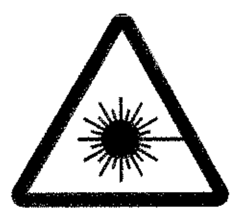


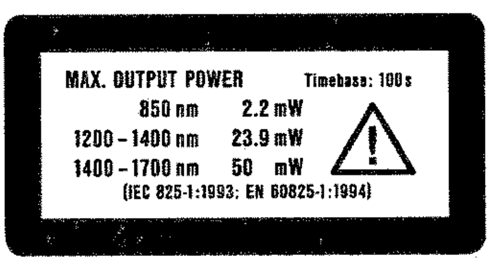




**Non-USA (All Tunable Laser Source Modules HP 81640A/80A/82A/89A)**

These laser safety warning labels are fixed on the outside of the HP 8164A Lightwave Measurement System before shipment.





A sheet of laser safety warnings is included with the laser module. You *MUST* stick the labels in the local language onto the outside of the instrument, in a position where they are clearly visible to anyone using the instrument.

You *MUST* return instruments with malfunctioning laser boxes to an HP Service Center for repair and calibration.

The laser module has a built in safety circuitry which will disable the optical output in the case of a fault condition.

**WARNING** Use of controls or adjustments or performance of procedures other than those specified for the laser source may result in hazardous radiation exposure.

**WARNING** Refer Servicing only to qualified and authorized personnel.

**WARNING** Do not enable the laser when there is no fiber attached to the optical output connector.

Tunable Laser Modules and Laser Source Modules have optical output connectors.

The laser is enabled by pressing the gray button close to the optical output connector on the front panel of the module. The laser is enabled when the green LED on the front panel of the instrument is lit.

**WARNING** Under no circumstances look into the end of an optical cable attached to the optical output when the device is operational.
The laser radiation can seriously damage your eyesight.

**WARNING** The use of optical instruments with this product will increase eye hazard.

## The Structure of this Manual

This manual is divided into 3 sections:

- Getting Started
  This section gives an introduction to the instrument and aims to make the instrument familiar to you:
  - *"Getting Started" on page 29* and
  - *"Additional Information" on page 53.*
- How to Use Modules and Applications
  This section gives information on how to control modules from the front panel:
  - *"Power Measurement" on page 69,*
  - *"Laser Sources" on page 91,*
  - *"Tunable Lasers" on page 101,*
  - *"Return Loss Measurement" on page 131,* and
  - *"Applications" on page 153.*
- Additional Information
  This section gives the following supporting information of a non-operational nature:
  - *"Installation and Maintenance" on page 199,*
  - *"Accessories" on page 223,*
  - *"Specifications" on page 231,*
  - *"Performance Tests" on page 241,*
  - *"Cleaning Procedures" on page 261,* and
  - *"Firmware Upgrades" on page 267.*

## Conventions used in this Manual

- Hardkeys are indicated by italics, for example, *Config*, or *Channel.*
- Softkeys are indicated by normal text enclosed in square brackets, for example, [Zoom] or [Cancel].
- Parameters are indicated by italics enclosed by square brackets, for example, [*Range Mode*], or [*MinMax Mode*].
- Menu items are indicated by italics enclosed in brackets, for example, <*MinMax*>, or <*Continuous*>.

# Contents

# Figures

# Tables

# Getting Started

This chapter introduces the features of the HP 8163A Lightwave Multimeter, the HP 8164A Lightwave Measurement System, and the HP 8166A Lightwave Multichannel System. Here you will find a quick description of the instrument, how to use the user interface and how to perform a simple sample session.

The central element of the instrument is the HP 8163A Lightwave Multimeter, the HP 8164A Lightwave Measurement System, and the HP 8166A Lightwave Multichannel System mainframes. You customize the instrument using plug-in modules and changeable fiber-connector interfaces. You can use this instrument as a tunable laser source and also to take associated measurements.

# HP 8163A Lightwave Multimeter

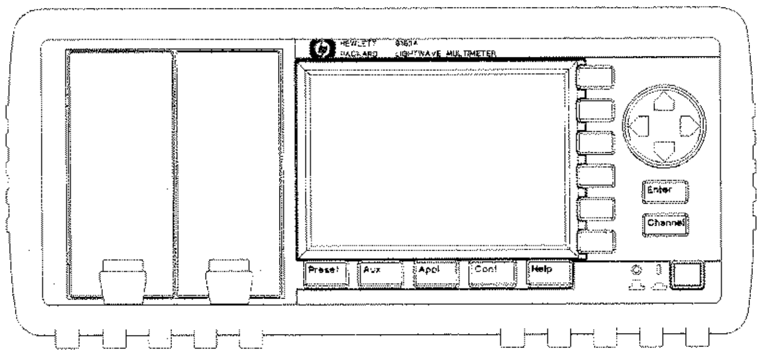



**Figure 1 The HP 8163A Lightwave Multimeter Mainframe**

The HP 8163A Lightwave Multimeter is a high-performance optical multimeter for the characterization and evaluation of optical components.

It's modular format makes it flexible enough to meet changing needs when measuring optical power, power loss, or return loss for single or multi-mode components.

The HP 8163A Lightwave Multimeter mainframe has two slim module slots. The system can host up to two front-loadable modules, of any combination of the following types:

- the HP 81689A Tunable Laser,
- Power Sensors, both dual and single,
- fixed wavelength Laser Sources, and
- Interface Modules for Optical Heads.

The front-loadable module slots support all modules designed for the HP 8153A Lightwave Multimeter.

# HP 8164A Lightwave Measurement System

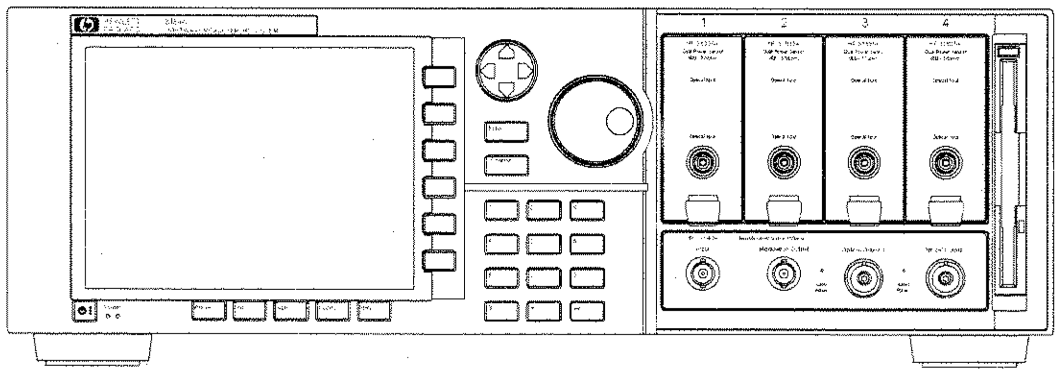


**Figure 2 The HP 8164A Lightwave Measurement System Mainframe**

The HP 8164A Lightwave Measurement System mainframe has one large and four slim module slots.

The system can host:

**1** one back-loadable Tunable Laser module

**2** and up to four front-loadable modules, of any combination of the following types:

- HP 81689A Tunable Laser,
- Power Sensors, both dual and single,
- fixed wavelength Laser Sources, and
- Interface Modules for Optical Heads.

The front-loadable module slots support all modules designed for the HP 8153A Lightwave Multimeter.

# HP 8166A Lightwave Multichannel System

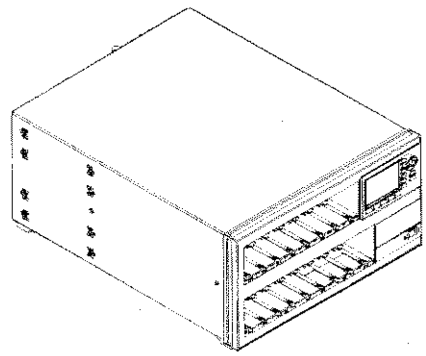


**Figure 3 The HP 8166A Lightwave Multichannel System Mainframe**

The HP 8166A Lightwave Multichannel System has 17 slim module slots.

The system can host up to seventeen front-loadable modules, of any combination of the following types:

- HP 81689A Tunable Laser,
- Power Sensors, both dual and single,
- fixed wavelength Laser Sources, and
- Interface Modules for Optical Heads.

The front-loadable module slots do not support any modules designed for the HP 8153A Lightwave Multimeter, that is, modules with part numbers less than HP 81600.

# A Description of the User Interface

Figure 4 and Figure 5 show the user interface of the HP 8164A and the HP 8163A/6A, respectively, and the names used in this manual to describe the groups of keys.

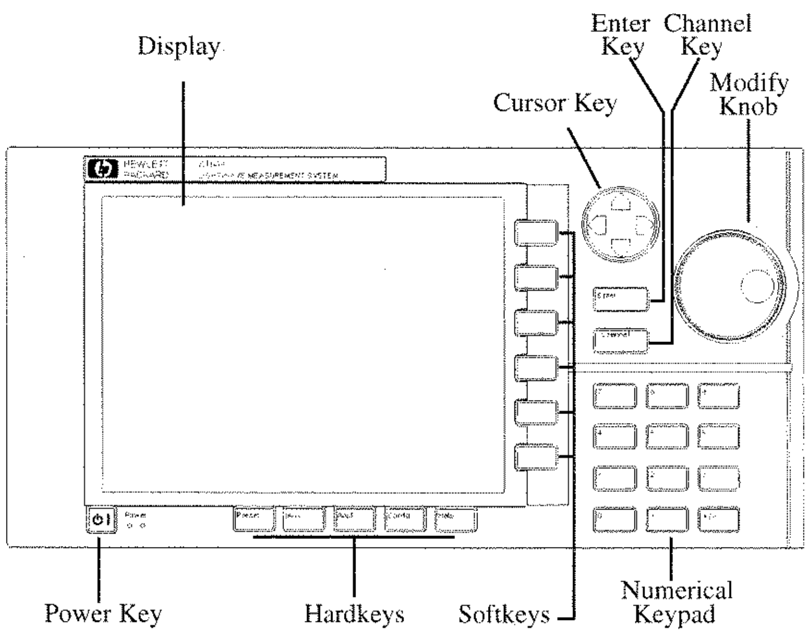



**Figure 4 The HP 8164A Lightwave Measurement System User Interface**

The HP 8163A and the HP 8166A do not provide the following two features of the HP 8164A's user interface:

- the Modify Knob, and
- the Numerical Keypad.

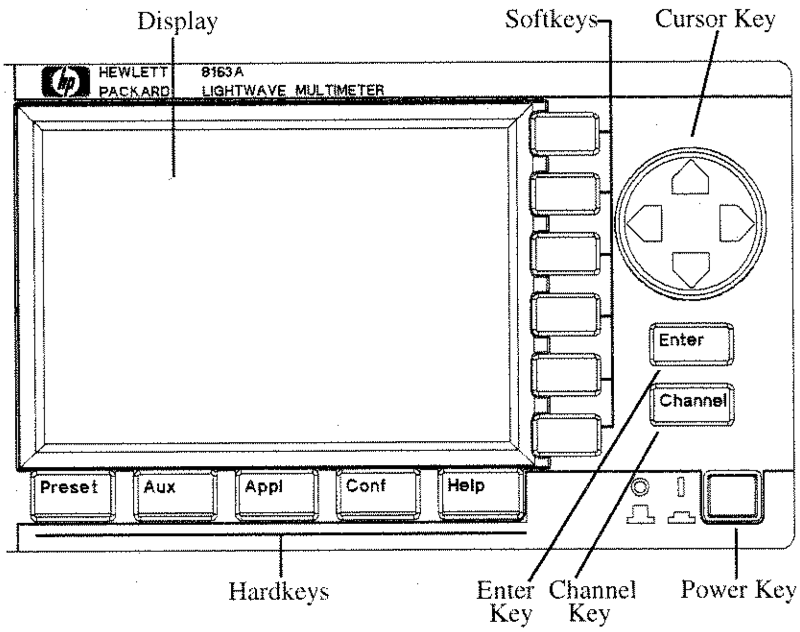



**Figure 5** **The HP 8163A Lightwave Multimeter User Interface**

# Password

When you use this instrument with high-power Laser Source modules or Tunable Laser modules, you must enter the password to unlock the instrument.

NOTE The default password is `1234`.

## If You Forget Your Password

If you forget your password, contact your nearest Agilent Technologies Sales/Service Office. Find contact details by accessing http://www.agilent.com/ on the internet.

# User Interface Features

## Introducing Softkeys

A softkey is a key whose function changes depending on the keys that you have pressed before. The function of the softkey is shown on the display to the left of the softkey.

## Introducing Hardkeys

A hardkey is a key that always has the same function.

## Special Module States

Besides parameter or measurement values, you may also see some texts instead.

`<empty>` The slot is empty.

`<unknown>` The installed module is not supported by the firmware revision.

## Slot and Channel Numbers

Each module is identified by a slot number and a channel number.

You can use slot and channel numbers:

- to identify each channel in the overview screen with a number at the side of the screen,
- to identify each channel in the Details screen with a tab at the top of the screen,
- to identify the channel when referencing the power measured by another channel, see *"How to Reference Another Power Measurement Channel" on page 75*,
- to identify the channel when using an application, see *"Applications" on page 153*, and
- to identify a channel when using a GPIB command. see the *HP 8163A Lightwave Multimeter, HP 8164A Lightwave Measurement System, & HP 8166A Lightwave Multichannel System Programming Guide* for more information on GPIB commands.

The slot number represents the module's position in the mainframe. Front-loadable modules are numbered:

- from one to two from left to right for the HP 8163A,
- from one to four from left to right for the HP 8164A, and
- from one to seventeen from left to right for the HP 8166A.

These numbers are displayed on the front panel beside each module slot. The HP 8164A slot for back-loadable modules is numbered zero.

NOTE Modules with two channels, for example, the HP 81635A Dual Power Sensor, use the channel number to distinguish between these channels.

The channel number of single channel modules is always one.

# How to Navigate/Modify the Display

## Overview Screen

Figure 6 shows the overview screen for the HP 8163A Lightwave Multimeter, this screen is shown immediately after start-up. It shows the most important parameters of all installed modules.

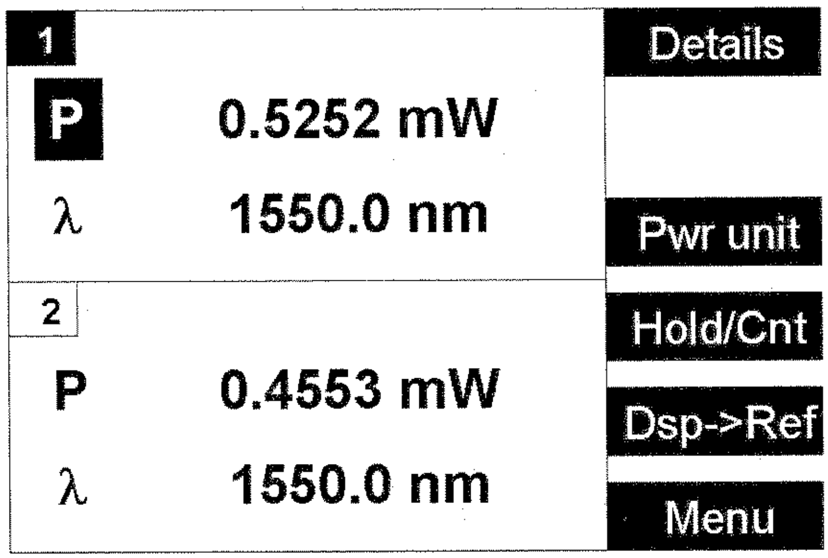



**Figure 6 The HP 8163A's Overview Screen**

Figure 7 shows the overview screen for the HP 8164A Lightwave Measurement System, this screen is shown immediately after start-up. It shows the most important parameters of all installed modules

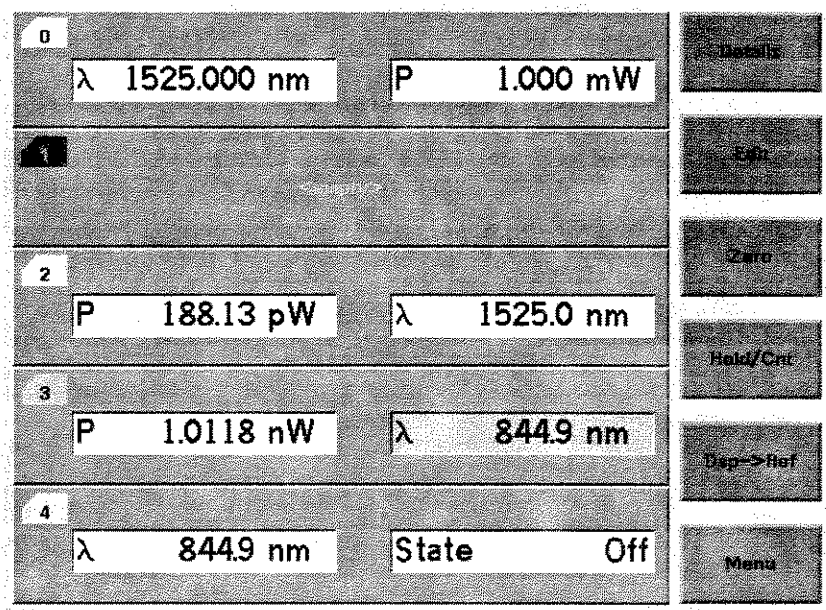



**Figure 7 The HP 8164A's Overview Screen**

Figure 8 shows the overview screen for the HP 8166A Lightwave Multichannel System, this screen is shown immediately after start-up. It shows the module slots that are occupied.

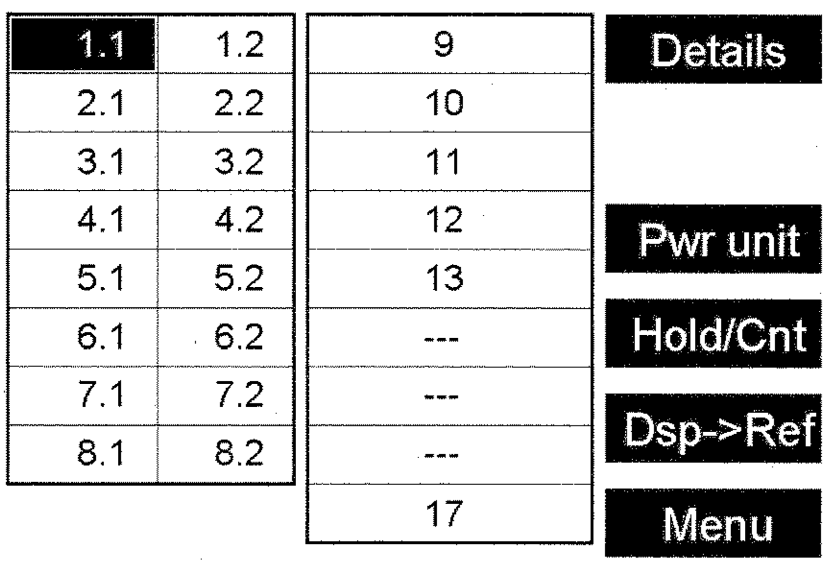



**Figure 8 The HP 8166A's Overview Screen**

## How to Use the Cursor Key

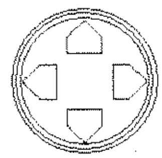


**Figure 9 The Cursor Key**

You can move the highlighted marker between parameters using the [Cursor] hardkey.

When editing a parameter, see *"How to Change the Value of a Parameter" on page 46*, the up and down cursor keys can be used to increment and decrement the value of a digit and the left and right cursor keys can be used to move the highlighted digit left and right.

## How to Use the Numerical Keypad

NOTE The Numerical Keypad is only available if you use the HP 8164A.

You can use the Numerical Keypad to change the value of a parameter. See *"How to Change the Value of a Parameter" on page 46.*

## How to Use the Modify Knob

NOTE The Modify Knob is only available if you use the HP 8164A.

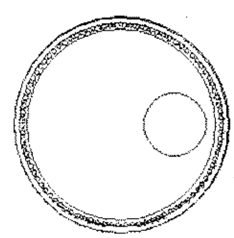


**Figure 10 The Modify Knob**

You can use the Modify Knob to navigate around the display. When you turn the Modify Knob through one click, one action is performed.

Turning the Modify Knob clockwise moves the highlighted marker right and then down. Turning the Modify Knob anti-clockwise moves the highlighted marker left and then up.

You can use the Modify Knob to change the value of a parameter. See *"How to Change the Value of a Parameter" on page 46.*

## How to Change Channel

You can navigate between module channels by pressing the *Channel* hardkey. You can use this key when either the overview screen or the details screen is displayed.

## How to Access the Details Screen

You can access the parameters of a module that are not shown on the overview screen by pressing *Channel* to select the channel and pressing the [Details] softkey. You should see the Details screen as shown in Figure 11, Figure 12, or Figure 13.

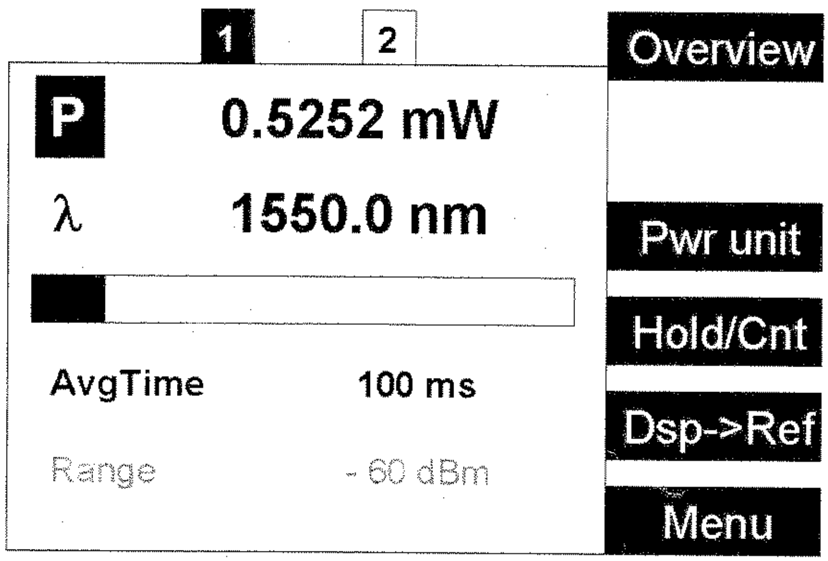



**Figure 11 The HP 8163A's Details Screen for a Power Sensor Channel**

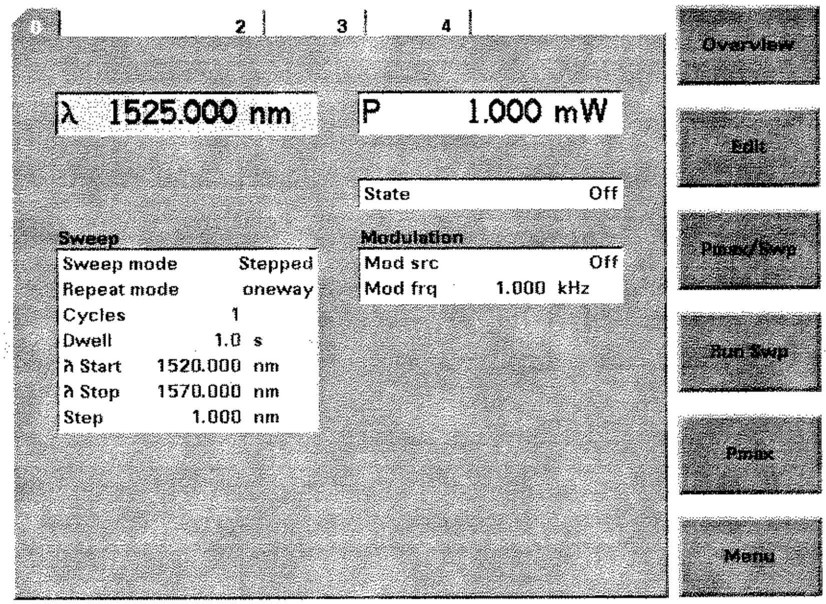



Figure 12 The HP 8164A's Details Screen for a Tunable Laser Channel

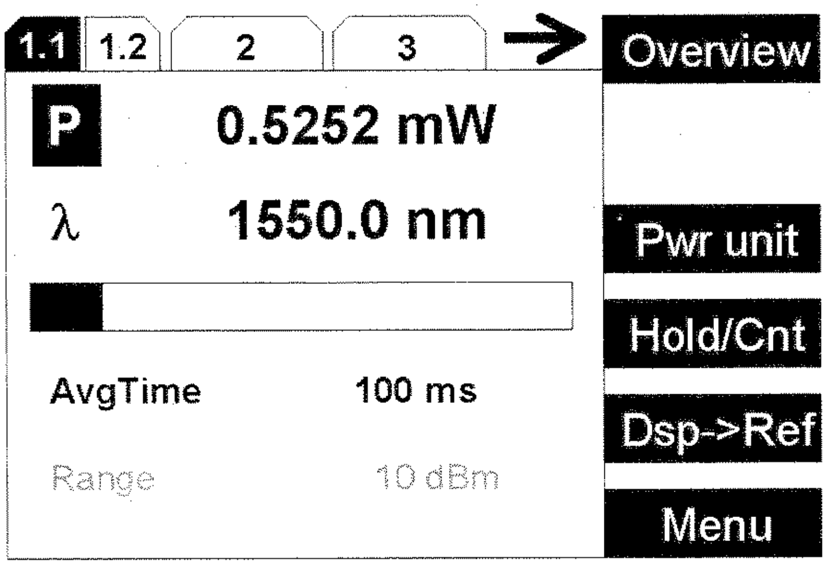



Figure 13 The HP 8166A's Details Screen for a Power Sensor Channel

If more than 3 modules are inserted in the HP 8166A Lightwave Multichannel System, the user interface cannot display each channel number in the details screen. The arrow indicates that undisplayed channels can be accessed by pressing the *Channel* hardkey.

To return to the overview screen press the [Overview] softkey.

## How to Access the Menu

Press the [Menu] softkey to access all the parameters and functions that apply to a module. Figure 14 and Figure 15 show the type of menu you should see for a Power Sensor channel.

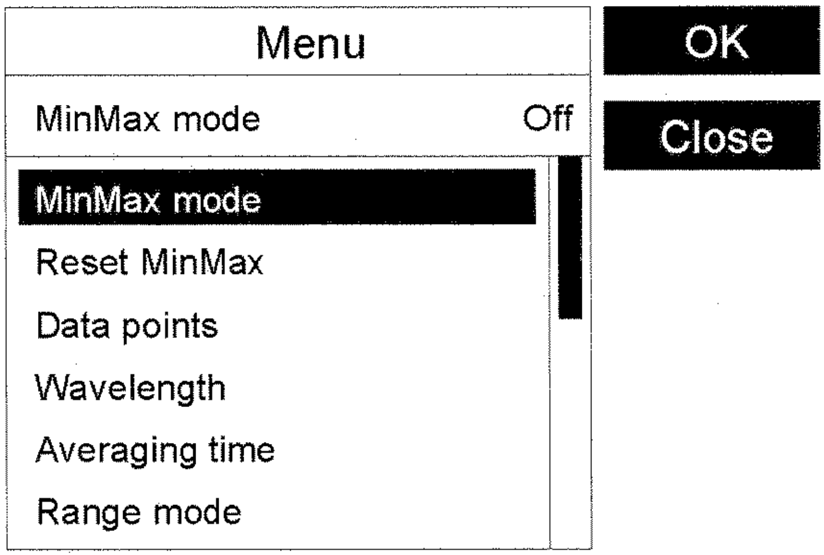



**Figure 14 The HP 8163A/6A Menu for a Power Sensor Channel**

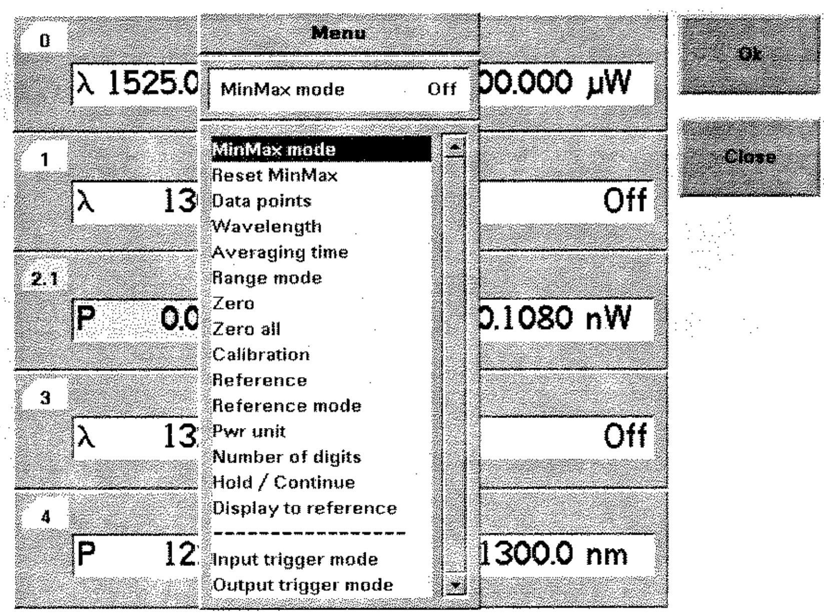



**Figure 15 The HP 8164A Menu for a Power Sensor Channel**

## How to Change the System Configuration

Press the *Config* hardkey to access all the system configuration parameters that can be changed. Figure 16 and Figure 17 show the menu you should see. See *"Additional Information" on page 53* for more details.

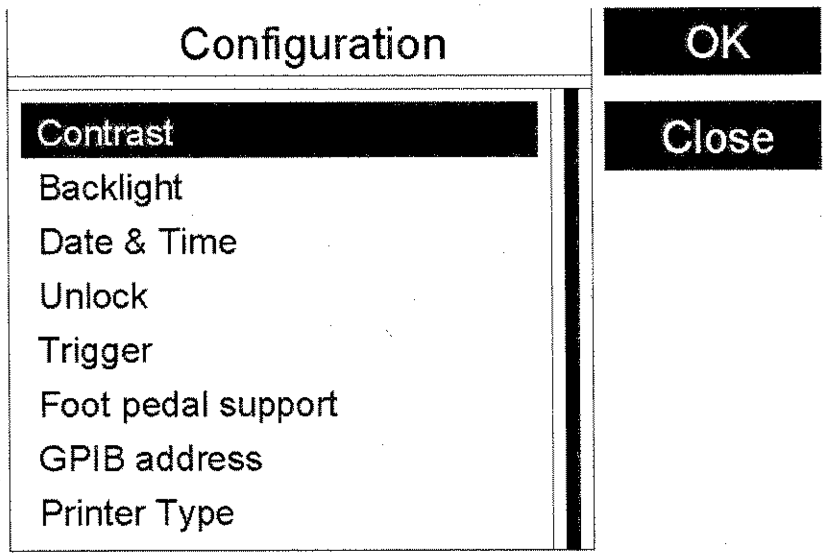



**Figure 16 The HP 8163A System Configuration Menu**

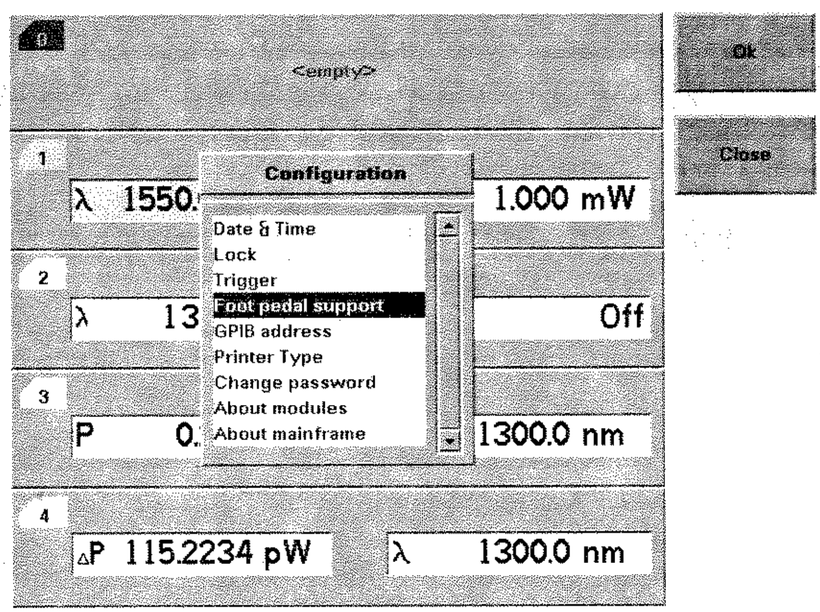



**Figure 17 The HP 8164A System Configuration Menu**

## How to Get Help

Press the *Help* hardkey any time you need more information. The instrument displays online documentation for the currently selected parameter.

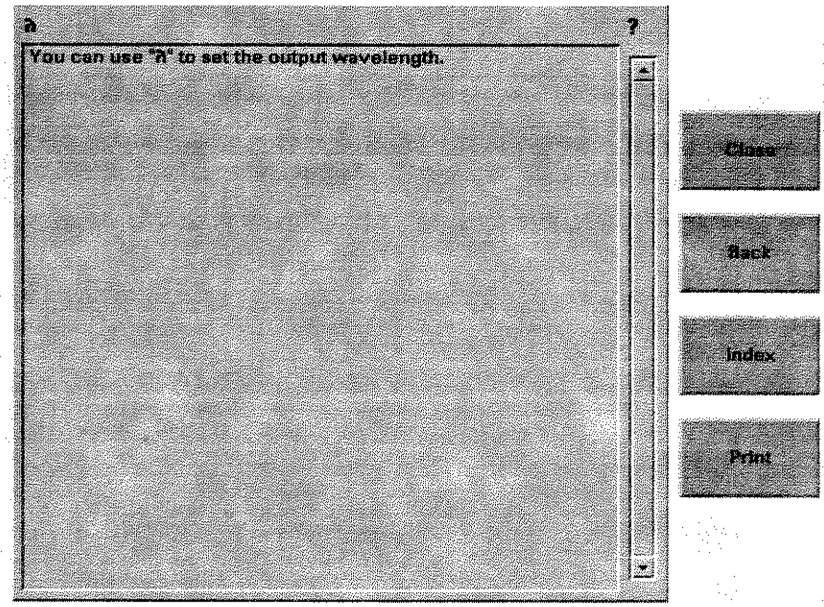



**Figure 18 The HP 8164A Help Screen**

Press the [Index] softkey to access the Index of help topics.

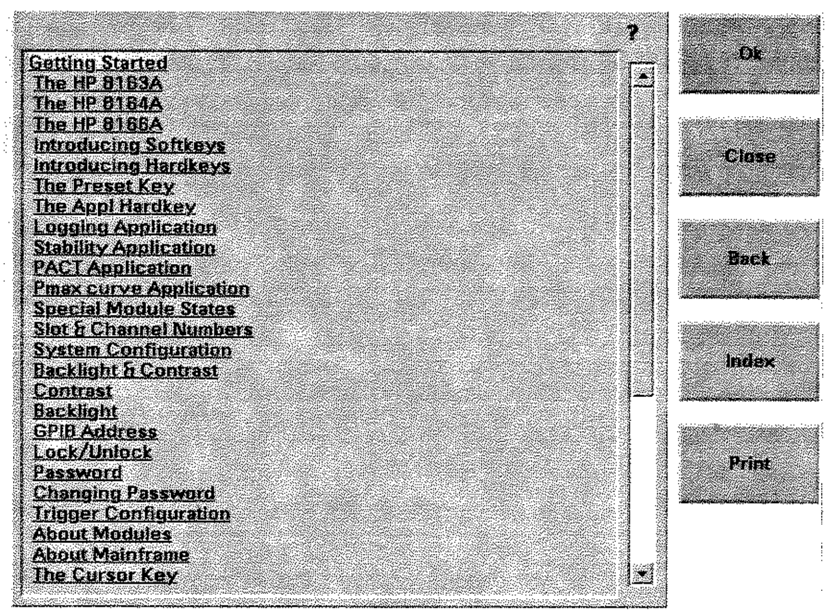



**Figure 19 The HP 8164A Help Index**

Press the [Back] softkey to return to the last Help topic you accessed.

You can scroll through the text using the up and down cursor keys. The scroll bar displays the current position in the text.

Cross-references within the text allow you to access relevant topics. Cross-references are underlined. If a cross-reference is highlighted, it is selected. Use the left or right cursor keys to move to another cross-reference. If you press the "Enter" hardkey or the [OK] softkey, you will jump to the chosen cross-reference.

Press the [Print] softkey to print the current help page. See *"How to Connect a Printer" on page 67* for more information on printing.

Press the [Close] softkey to leave the online documentation and resume your task.

## How to Access Applications

You can access these applications for the HP 8163A Lightwave Multimeter or HP 8164A Lightwave Measurement System by pressing the *Appl* hardkey, the Applications Menu appears, as shown in Figure 20. See *"Applications" on page 153* for further details.

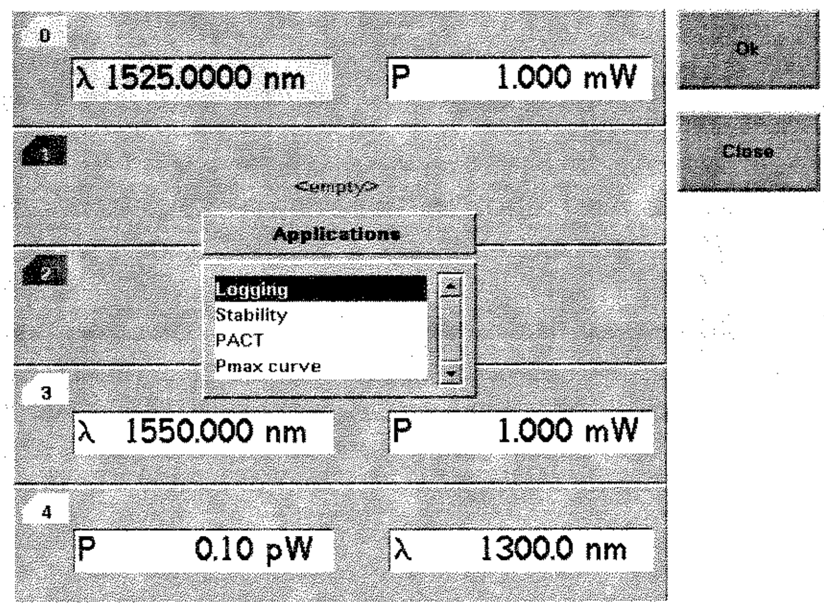



**Figure 20 The Applications Menu**

NOTE These applications are not available for the HP 8166A Lightwave Multichannel System.

NOTE After you exit from the application, any modules selected by these applications will automatically be preset, all parameters will be set to their default values for the selected modules.

# How to Change the Value of a Parameter

What follows is a description of the various ways of changing the value of parameters. Examples in which particular parameter values are changed are given with the parameter descriptions.

Parameters can be either:

- continuous, you may choose any value within a given range, or
- discrete, you may choose a value from a menu.

## How to Select a Parameter

You can select the parameter from the following screens:

- from the Details screen, after pressing the [Details] softkey,
- from the Menu screen, after pressing the [Menu] softkey, or,
- for the HP 8163A and HP 8164A, from the Overview screen.

To start editing a parameter, you move to it and:

- press the *Enter* hardkey,
- press the [Edit] softkey,
- press the Modify Knob (if you are using the HP 8164A), or,
- for numerical parameters only, type a digit on the numerical keypad (if you are using the HP 8164A).

## How to Accept the New Value of a Parameter

When you have changed the value of a parameter, to accept this change:

- press the *Enter* hardkey,
- press the [OK] softkey,
- or, press the Modify Knob (if you are using the HP 8164A).

These keys all perform the same purpose. All references to pressing *Enter* throughout this User's Guide, refer to one of these three actions.

# How to Make a Big Change to a Continuous Parameter

If you are changing the value of a parameter completely, type in the value on the numerical keypad (if you are using the HP 8164A), and press *Enter*.

To change the output power from 100 µW to 755 µW:

1 Press the [Menu] softkey.

2 Move to Power, using the cursor key, and press *Enter*.

3 Type 755.000 on the numerical keypad and press *Enter*.

# How to Make a Small Change to a Continuous Parameter

For small changes to a parameter use the up and down cursor keys, the numerical keypad (if you are using the HP 8164A), or the modify knob (if you are using the HP 8164A).

Move to the parameter and then:

1 Press [Edit]. The first digit before the decimal point will be highlighted first, as shown in Figure 21.

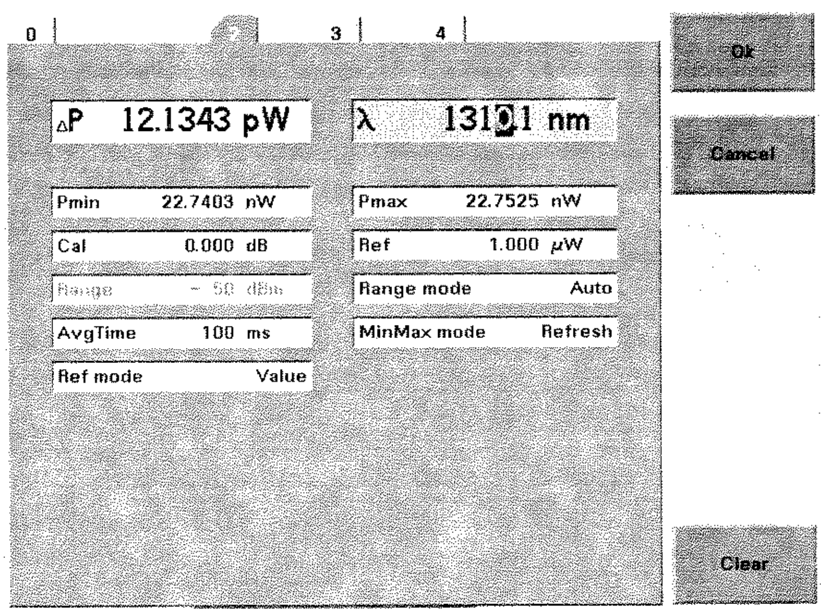



**Figure 21 The First Digit Before the Decimal Point is Highlighted First**

2 If you want to select another digit to edit, use the left or right cursor key.

3 Enter the new value for the digit by using the numerical keypad, the up and down cursors or turning the modify knob.

4 Repeat steps 2 and 3 to continue editing the value.

5 When you have finished editing the value, press *Enter*. The edited value becomes the new value of the parameter.

To change the wavelength from 1540.000 nm to 1525.000 nm:

1 Move to the wavelength parameter for a Tunable Laser module and press [Edit]. The most significant digit is highlighted.

2 Press the left cursor once to highlight the digit four.

3 Press the down cursor twice to change the value of the digit to two.

4 Press the right cursor once to move the cursor one digit right.

5 Press the up cursor five times to change the value of the digit to five. Press *Enter* to end the editing.

## How to Change a Discrete Parameter

For discrete parameters, you may choose a particular values within a given range.

For a Power Sensor module:

1 Move to the Power Sensor channel and press the [Details] softkey.

2 Move to the [*AvgTime*] parameter and press *Enter*.

3 Move to 1 s, by using the cursor key, and press *Enter*.

or

1 Move to the Power Sensor channel and press the [Menu] softkey.

2 Move to the <*Averaging Time*> parameter and press *Enter*. You see the screen in Figure 22.

3 Move to <1 s>, by using the cursor key, and press *Enter*.

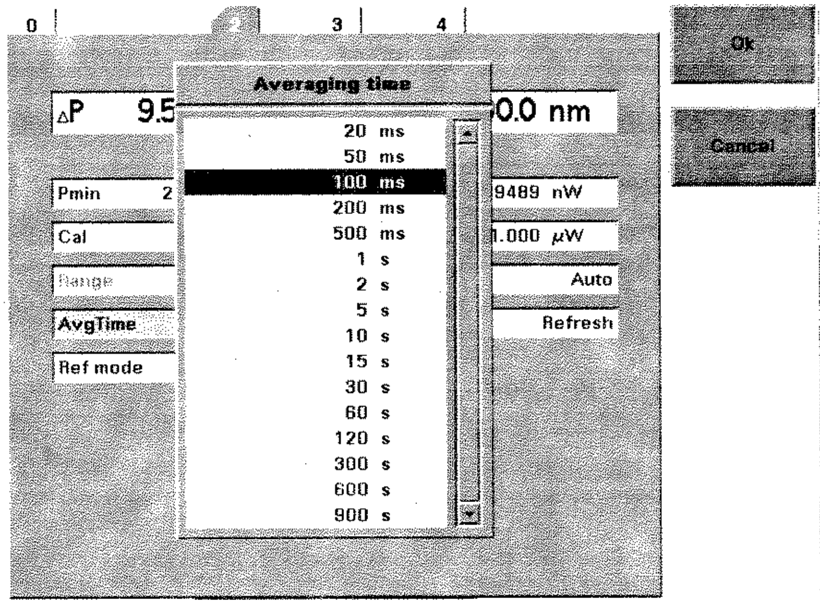



**Figure 22** Averaging Time Menu

# How to Set All Parameters to Their Default Values

Press *Preset* to set all parameters to their default values.

# If You Make a Mistake

If you make a mistake while you are editing a parameter, you can cancel the editing, and retain the previous value for the parameter by pressing the [Cancel] softkey.

# If the Parameter Changes to Different Value

If you press *Enter* or the [OK] softkey and the parameter changes to a different value, then you tried to enter a value outside the calibrated range. The new value is the nearest valid value to the value you entered.

# A Sample Session

This sample session shows you how to measure the power of a modulated signal at a single wavelength.

The sample session is written for the HP 8163A Lightwave Multimeter or HP 8164A Lightwave Measurement System, the HP 81689A Tunable Laser module, and the HP 81532A Power Sensor. To perform the sample session as described here, you also need a patchcord (if you are using the 81000AI Connector interface, then a Diamond HMS-10/HP/HRL to Diamond HMS-10/HP patchcord, HP 81109AC).

## How to Measure the Power of a Modulated Signal

We want to measure the power of a 1540 nm signal, modulated by a 100 kHz square wave, at 500 µW.

1 Make sure that all your connectors, and connector interfaces are clean.

2 Make sure that the Optical Output of the Laser Source is not active.

3 Connect the output of the Laser Source to the input of the Power Sensor module, as shown in Figure 23. You must connect the correct fiber end connector for your Tunable Laser module:

   a For straight contact connectors, use a straight contact fiber end connector with a black sleeve.

   b For angled contact connectors with a green sign beside the Tunable Laser module's optical output connector, use an angled contact fiber end connector with a green sleeve.

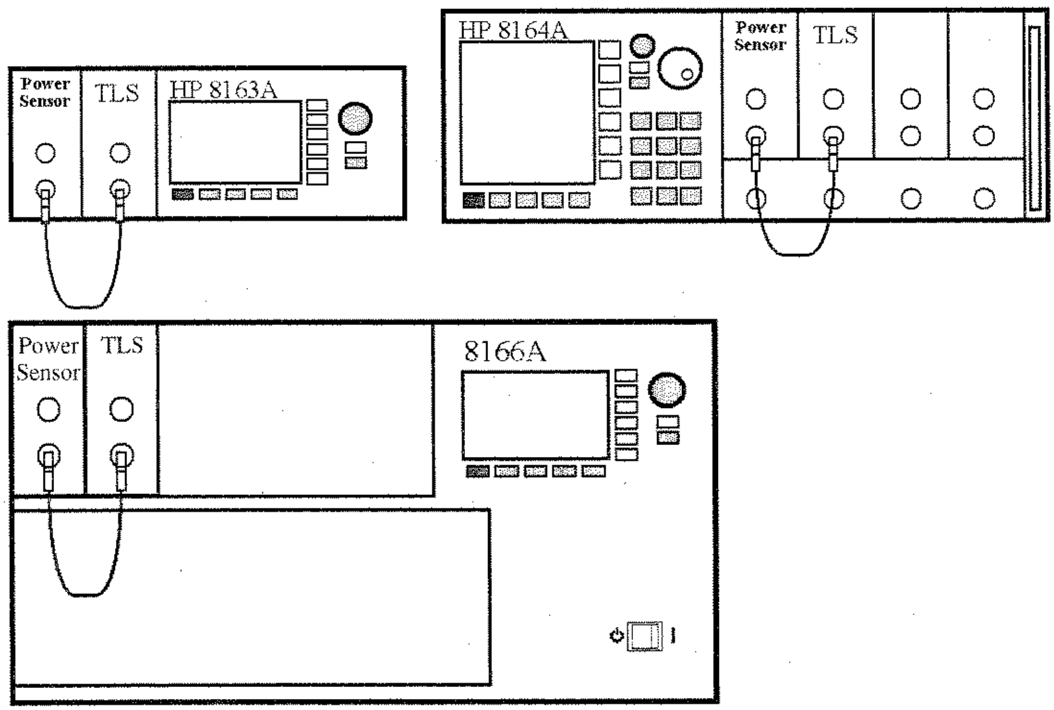



**Figure 23 Connecting the Instrument for the Sample Session**

4 Make sure the instrument is powered up.

5 How to set the wavelength for the Power Sensor module:

   a Move to the wavelength parameter, [λ], for the Power Sensor module and press *Enter*.

   b Enter 1540.000 and press *Enter*.

6 How to set the averaging time for the Power Sensor module:

   a Move to the measurement averaging time, [*Tavg*], and press *Enter*.

   b Move to <*1 s*>, using the cursor key, and press *Enter*.

7 For the Power Sensor module, make sure that Watts are the selected Power Unit and that the instrument is in automatic ranging mode. To change these settings:

   a Move to the power parameter, [*P*], and press the [Power Unit] softkey.

   b Move to <*W*>, using the cursor key, and press *Enter*.

   c Move to the [*Range Mode*] parameter and press *Enter*.

   d Move to <*Auto*>, using the cursor key, and press *Enter*.

8 How to set the wavelength for the Tunable Laser module:

   a Move to the wavelength parameter, [λ], for the Tunable Laser module and press *Enter*.

   b Enter 1540.000 and press *Enter*.

**9** How to set the modulated power for the Tunable Laser module:

a If power is not displayed in Watts, move to the [*P*] parameter and press the [Power Unit] softkey.

b Move to <*W*>, using the cursor key, and press *Enter.*

c Move to the [*P*] parameter and press *Enter.*

d Enter 500.000.

e Change units to μW, if necessary, using the [Unit+] or [Unit–] softkey.

f Press *Enter.*

**10** How to set the modulation frequency for the Tunable Laser module:

a Select the [*Frequency*] parameter and press *Enter.*

b Enter 100.000 and press *Enter.*

**11** For the Tunable Laser module, press the button beside the Optical Output. The green LED should switch on to indicate that the laser is now active.

You should notice that the power reading is approximately half the value set on the Tunable Laser module. This is because the output is modulated by a square wave with a 50% duty cycle.

# Additional Information

This chapter describes the system functions of the HP 8163A Lightwave Multimeter, the HP 8164A Lightwave Measurement System, and the HP 8166A Lightwave Multichannel System. Here you will find out how to set the configuration settings and how to connect an external monitor.

# Using the System Utilities

Press the *Config* hardkey to access configuration information for your mainframe. You see the screens in Figure 24 and Figure 25.

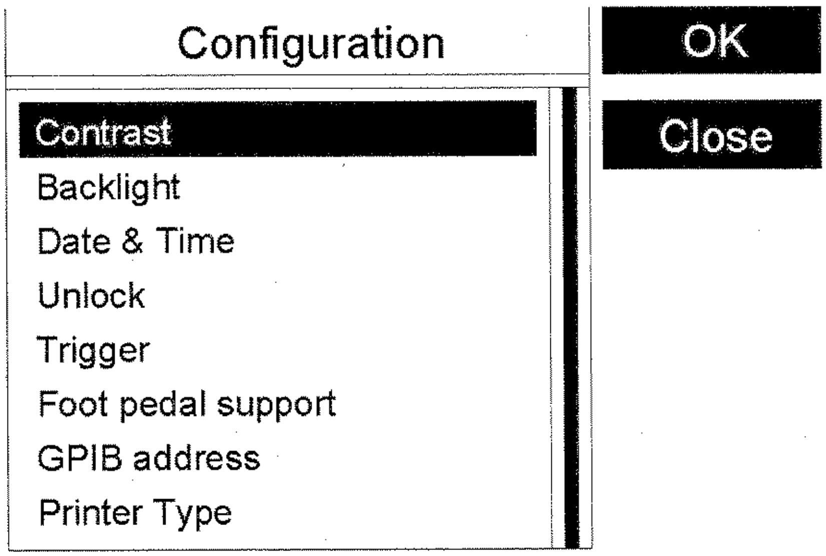



**Figure 24 The HP 8163A/6A System Configuration Menu**

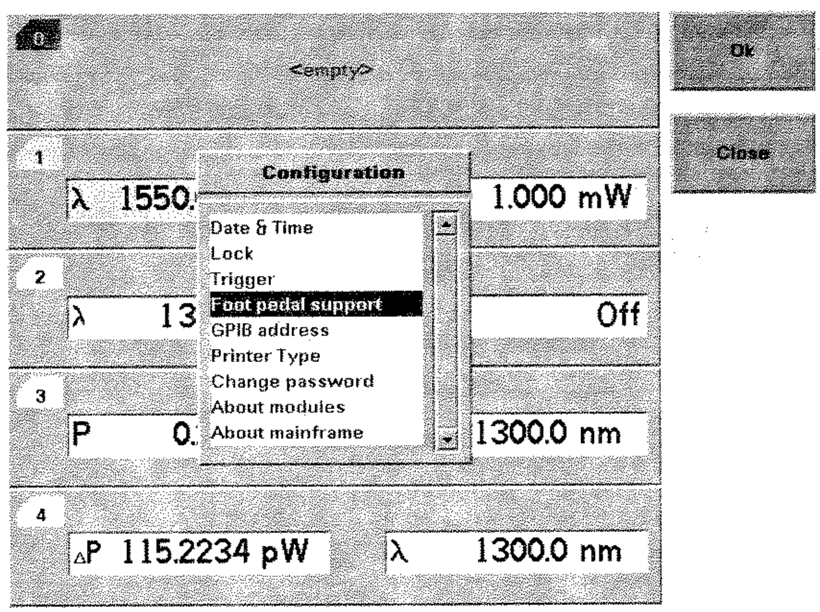



**Figure 25 The HP 8164A System Configuration Menu**

You can move to any of the menu items by using the cursor key or the Modify knob. Select an item by pressing *Enter* or the [OK] softkey.

# How to Set the Backlight & Contrast

The Backlight and Contrast menu options allow you to change the appearance of the screen.

NOTE The Backlight and Contrast menu options are supported by the HP 8163A and HP 8166A but not by the HP 8164A.

## To Set the Contrast

To change the contrast level of the HP 8163A/6A's screen:

1 Press the *Config* hardkey.

2 Move to the <*Contrast*> menu option and press *Enter*. You see a box displaying the current setting.

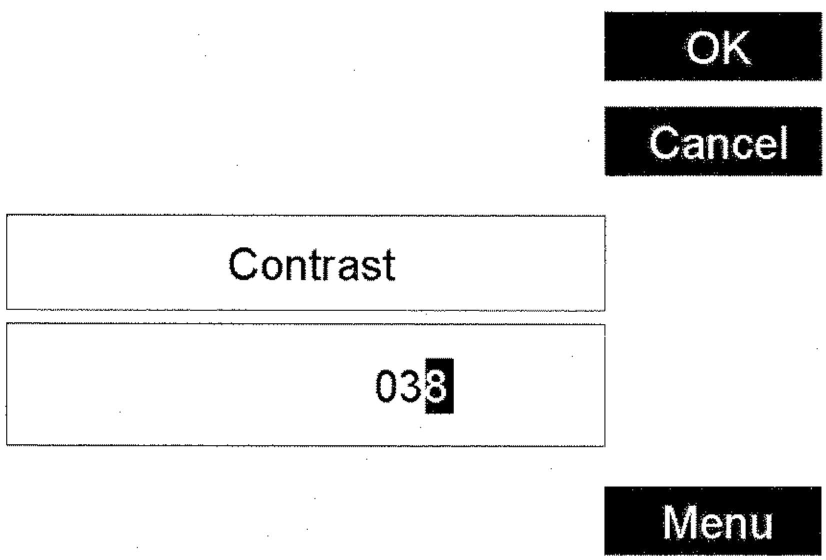



**Figure 26 Entering a Contrast Value**

3 Enter an integer value between zero and one hundred in this box and press *Enter*.

## To Set the Backlight

To change the backlight level of the HP 8163A/6A's screen:

1 Press the *Config* hardkey.

2 Move to the <*Backlight*> menu option and press *Enter*. You see a box displaying the current setting.

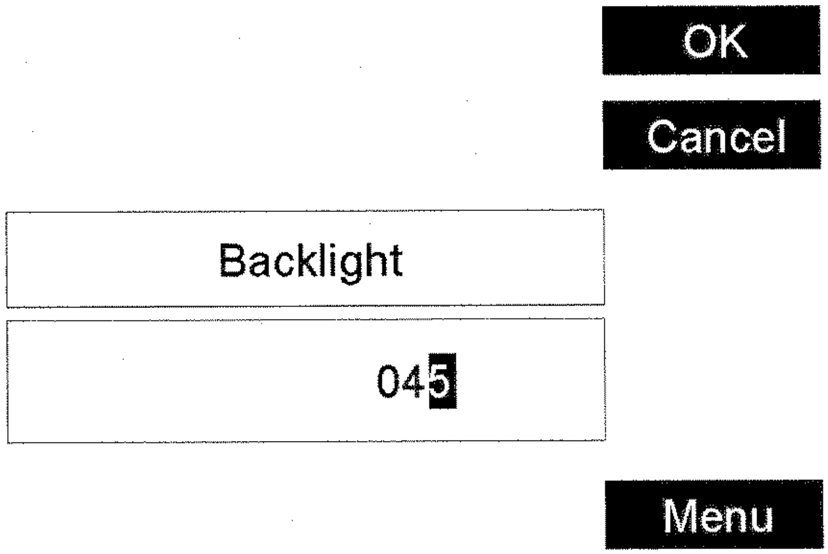



**Figure 27 Entering a Backlight Value**

3 Enter an integer value between zero and one hundred in this box and press *Enter*.

# How to Set the Date & Time

The instrument uses the date and time when:

- you print out data from an application,
- you save data to diskette from an application, and
- you send the `:SYSTem:DATE?` or `:SYSTem:TIME?` GPIB commands, see your instrument's Programming Guide for more details.

To set the date and time:

1 Press the *Config* hardkey.

2 Move to the <*Date & Time*> menu option and press *Enter*. You see a box, similar to Figure 28, displaying the current date and time settings.

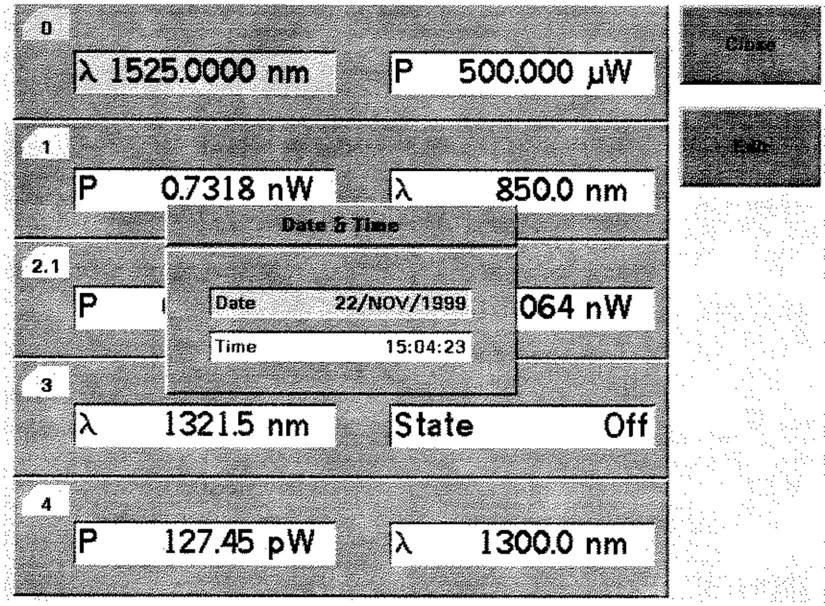



**Figure 28 Editing the Date and the Time**

3 Use the cursor key to move to the Date field. Press the [Edit] softkey. The day of the month is highlighted.

4 Use the left and right cursor keys to move to the day, month or year. Edit the day, month or year using the cursor key. Press *Enter*.

5 Perform steps 3 to 4 again if the date is not fully correct.

6 Use the cursor key to move to the Time field. Press the [Edit] softkey. The hour of the day is highlighted. The 24-hour clock is used.

7 Use the left and right cursor keys to move to the hour, minute, or second. Edit the hour, minute, or second using the cursor key. Press [OK].

8 Perform steps 6 to 7 again if the date is not fully correct.

9 When the time and date are both correct, press [Close] to return to the configuration menu.

# How to Set the GPIB Address

NOTE The default GPIB address is *20*.

To set the GPIB address:

1 Press the *Config* hardkey.

2 Move to the <*GPIB Address*> menu option and press *Enter*. You see a box displaying the current GPIB address.

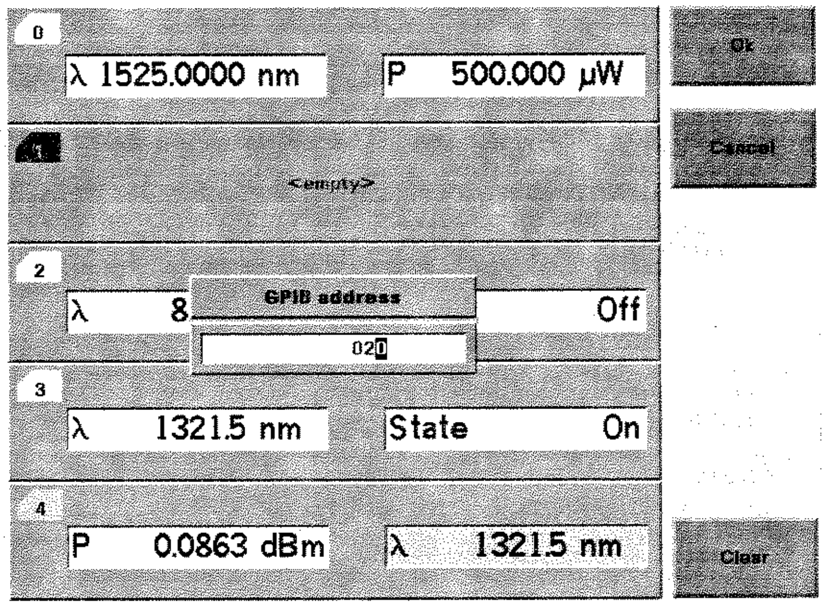



**Figure 29 Entering a GPIB Address**

3 Enter an integer value between 0 and 30 into this box and press *Enter*. The address is set to this value.

NOTE Avoid using 21as the GPIB address because this number is often the controller's default GPIB address.

# How to Select the Printer Type

You can use a printer connected to the parallel port on the rear panel of your mainframe, see *"Input and Output Connectors" on page 216* for a diagram of your mainframe's rear panel.

You can print out any of the following information:

- a help screen, see *"How to Get Help" on page 44*,
- data from an application, see *"Printing Application Measurement Results" on page 194*.

To select a printer type:

1 Press the *Config* hardkey.

2 Move to the <*Printer Type*> menu option and press *Enter*. You see a box, as shown in Figure 30, displaying the following printer types:

– <*HP PCL*>, you can use any printer that uses the Hewlett-Packard Printer Control Language Level 3 or higher, and

- <*EPSON 8 pin*>, you can use any printer that is compliant with Epson 8 pin printers.

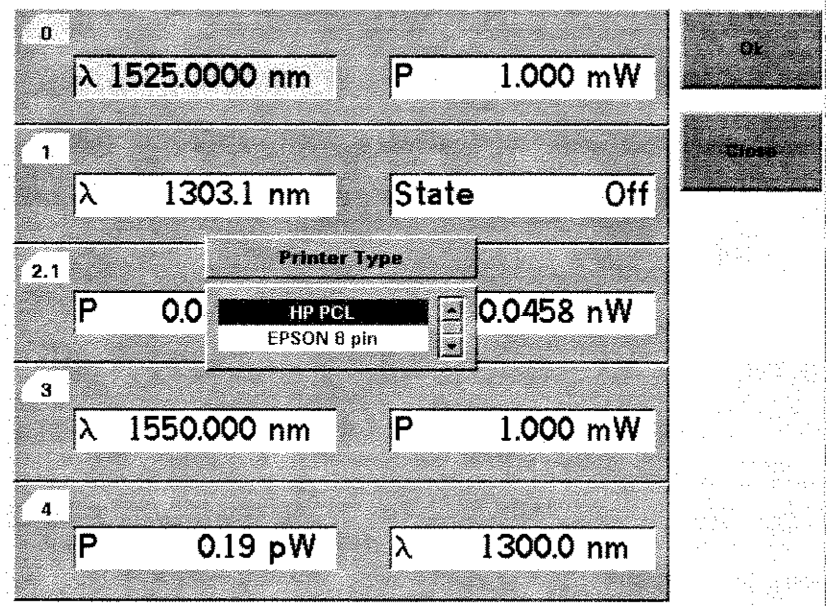



**Figure 30 Selecting a Printer Type**

3 Move to your printer type and press *Enter*. You return to the configuration menu.

# How to Lock/Unlock the High-Power Laser Sources

To unlock high-power laser sources (including Tunable Laser modules):

1 Press the *Config* hardkey.

2 Move to the <*Unlock*> menu option and press *Enter*. You see a box requesting you to enter the password.

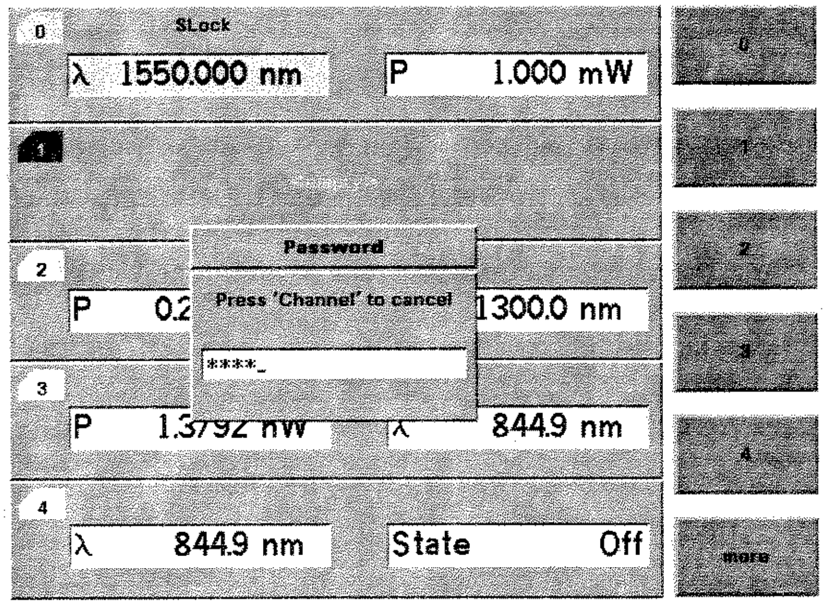



**Figure 31 Unlocking the Instrument**

3 Enter the password, using the softkeys or the numerical keypad. Press *Enter* and the instrument unlocks.

NOTE The default password is `1234`.

To lock the instrument, perform the steps above, but in step 2 move to the <*Lock*> menu option in place of the <*Unlock*> menu option.

# How to Change the Password

The password is used for unlocking the instrument. To change the password:

1 Press the *Config* hardkey.

2 Move to the <*Change Password*> menu option and press *Enter*. You see a box requesting you to enter the password.

3 Enter the password, using the softkeys or the numerical keypad and press *Enter*. You are asked to enter the new password.

4 Enter your new password. It should be 4 digits long. Press *Enter*. You are asked to enter the new password again.

5 Enter your new password again and press *Enter*.

# If You Forget Your Password

If you forget your password, contact your nearest Agilent Technologies Sales/Service Office. Find contact details by accessing http://www.agilent.com/ on the internet.

# How to Set the Trigger Configuration

The trigger level at the external trigger connectors is by default active high, this means when a trigger rises above the high TTL level, a trigger is accepted.

You can select three modes of triggering from the trigger configuration menu:

- <*None*>, which you should choose if you do not want to use triggering.
- <*Default*>, which you should choose if you want to enable the trigger connectors.
- <*Pass Through*>, which you should choose if you want an input trigger to automatically generate an output trigger. This allows you to trigger another instrument almost simultaneously.
- <*Loopback*>, which you should choose if you want an output trigger to automatically generate an input trigger. For example, using this mode, you could trigger each step of a wavelength sweep with just one externally generated input trigger.

To change the triggering mode:

1 Press the *Config* hardkey.

2 Move to the <*Trigger*> menu option and press *Enter*. You see a box displaying the available triggering modes.

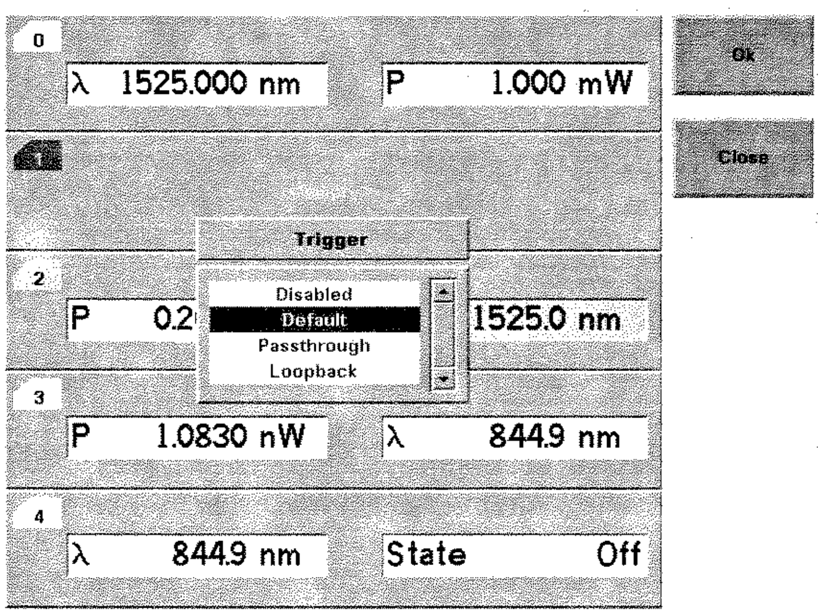



**Figure 32 Changing the Triggering Mode**

3 Move to your chosen triggering mode and press *Enter*.

# How to Configure your Foot Pedal

You can use a HP 81610FP Foot Pedal (*HP Part Number 81610-68709*) to generate triggers. This accessory is similar to a mouse, you press the Foot Pedal and a trigger is generated. You can attach the Foot Pedal to the Input Trigger BNC Connector, see *"Input and Output Connectors" on page 216*.

To configure your Foot Pedal:

1 Press the *Config* hardkey.

2 Move to the <*Foot pedal support*> menu option and press *Enter*. You see a box displaying <*On*> and <*Off*>.

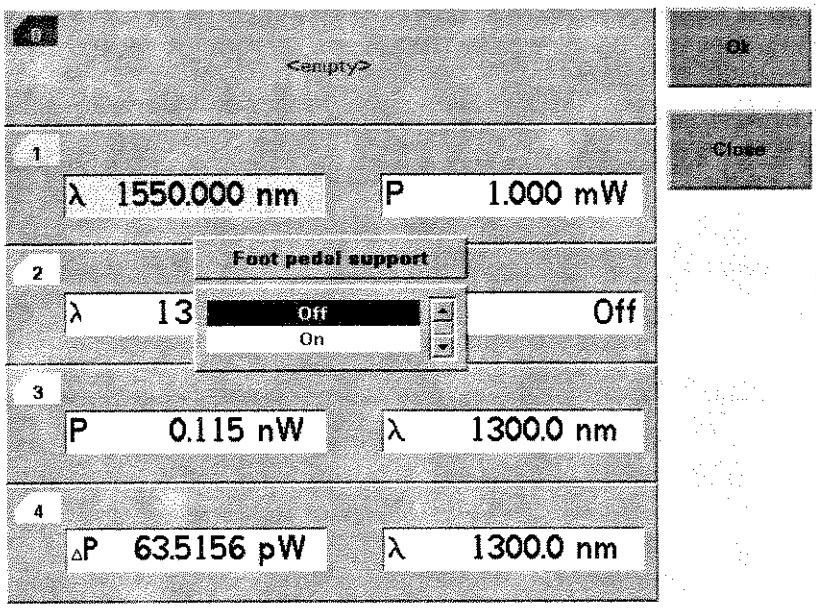



**Figure 33 Enabling/Disabling the Foot Pedal**

3 Move to <*On*> to enable the HP 81610FP Foot Pedal or move to <*Off*> to disable the HP 81610FP Foot Pedal.

4 Press *Enter*.

# How to Get Information About Modules

To get information about modules:

1 Press the *Config* hardkey.

2 Move to the <*About Modules*> menu option and press *Enter*. You see a box displaying the slots which have installed modules, see Figure 34.

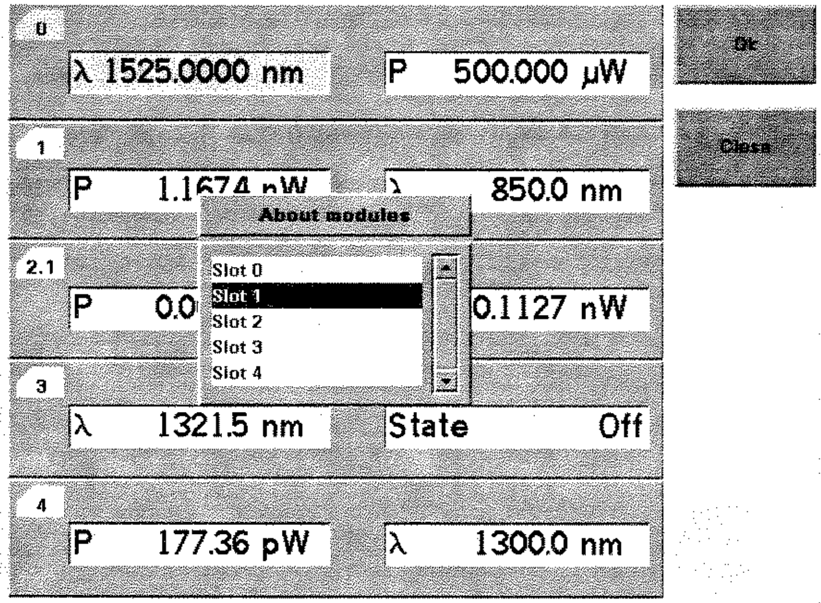



**Figure 34 Slots with Installed Modules**

3 Move to the module using the cursor key for which you require information. Press *Enter*.

4 The part number, serial number, and firmware revision of the chosen module are displayed, as shown in Figure 35.

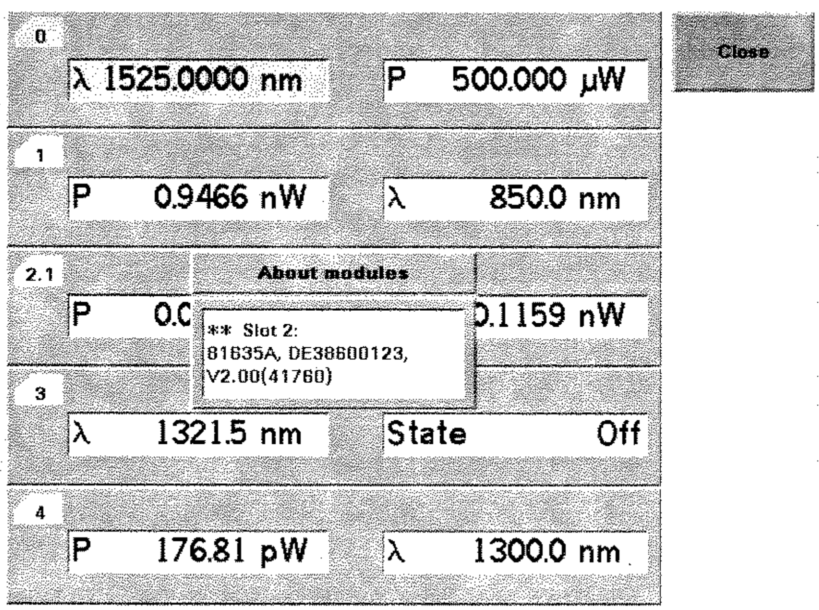



**Figure 35 Viewing Information About a Module**

5 Press [Close] to return to the menu in Figure 34.

6 Perform steps 3 to 5 to view information about other module slots or press [Close] to return to the configuration menu.

NOTE

- The HP 81640A/80A/82A/89A Tunable Laser modules will always return `HEWLETT-PACKARD` as the manufacturer.
- All other HP 8163A Series modules return `Agilent Technologies` as the manufacturer.
- The HP 8153A Series modules will always return `HEWLETT-PACKARD` as the manufacturer.

See *"How to Get Information About the Mainframe" on page 65* for information on mainframe identity strings.

# How to Get Information About the Mainframe

To get information about the mainframe:

1 Press the *Config* hardkey.

2 Move to the *<About Mainframe>* menu option and press *Enter*. You see a box displaying information about your mainframe, see Figure 36. The manufacturer, part number, serial number, and firmware revision of the mainframe are listed.

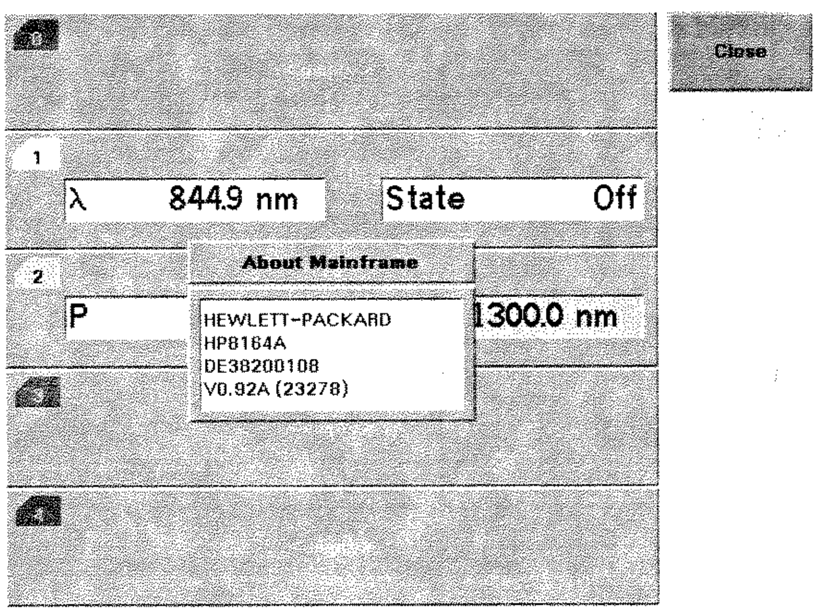



**Figure 36 Viewing Information About the Mainframe**

3 Press [Close] to return to the configuration menu.

**NOTE** The HP 8163A, HP8164A, and HP8166A will always return HEWLETT-PACKARD as the manufacturer. This will not be affected by the transition of these instruments to Agilent Technologies. This will allow programs that use this string to continue functioning.

See *"How to Get Information About Modules" on page 63* for information on module identity strings.

# How to Connect an External Monitor

You can connect a standard VGA monitor to the HP 8164A Lightwave Measurement System. This is a useful feature for making presentations or for training courses.

**NOTE** You cannot connect a monitor to the HP 8163A Lightwave Multimeter or HP 8166A Lightwave Multichannel System.

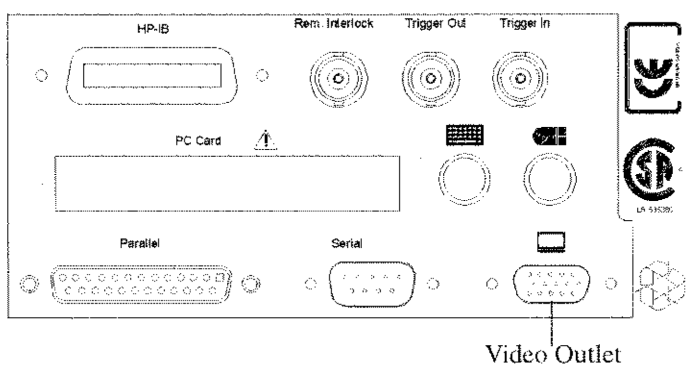



**Figure 37** **Rear Panel of the HP 8164A Lightwave Measurement System**

- Place your monitor on a flat sturdy surface.
- Before you make any connections make sure the Lightwave Measurement System and monitor are turned off.
- Connect the power cable to the video input on the back of your monitor. Tighten the thumbscrews on the plug.
- Connect the video cable (it has a 15-pin plug) to the video outlet on the back of the Lightwave Measurement System. Tighten the thumbscrews on the plug.
- Connect the power cord to the display.

- Plug the power cord into the power outlet.

NOTE Refer to the user's guide that came with your monitor, if necessary, to locate your monitor's output and input ports.

# How to Connect a Printer

You can use a printer connected to the parallel port on the rear panel of your mainframe, see *"Input and Output Connectors" on page 216* for a diagram of your mainframe's rear panel.

You can use either of the following printer types:

- *<HP PCL>*, a printer that uses the Hewlett-Packard Printer Control Language, or
- *<EPSON 8 pin>*, a printer that is compliant with Epson 8 pin printers.

To set up the printer, perform the following steps:

1 Set up your printer as described in your printer's User's Guide.
2 Connect a parallel cable between your printer's parallel connector to the parallel port on the rear panel of your mainframe, see *"Input and Output Connectors" on page 216* for a diagram of your mainframe's rear panel.
3 To select a printer type, see *"How to Select the Printer Type" on page 59.*

You can then print out any of the following information:

- a help screen, see *"How to Get Help" on page 44.*
- data from an application, see *"Printing Application Measurement Results" on page 194.*

# Power Measurement

This chapter describes how to use the HP 8163A Lightwave Multimeter, the HP 8164A Lightwave Measurement System, and the HP 8166A Lightwave Multichannel System to measure optical power using a Power Meter, that is:

- a Power Sensor module or
- an Optical Head in conjunction with an Optical Head Interface module.

# How to Measure Power

## The Power Value

The <*P*> parameter displays the power measurement value. In MinMax mode, this parameter changes to <Δ*P*>, the difference between minimum and maximum power, see *"How to Choose the MinMax Mode" on page 84*.

### How to Set the Number of Digits

You can set the maximum number of digits that are used in power measurement. This is the maximum number of digits after the decimal point.

To change the number of digits to two:

1 Move to the Power Meter channel and press the [Menu] softkey.

2 Move to <*Number of Digits*> option and press *Enter*. You will see the screen in Figure 38.

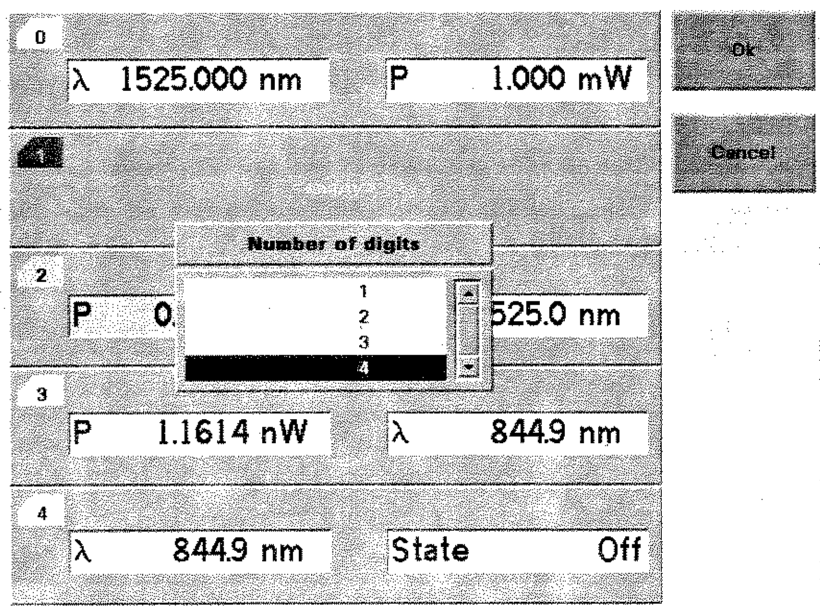



**Figure 38 The Number of Digits Menu**

3 Move to 2 and press *Enter*.

4 Press the [Close] softkey to exit the menu.

## How to Set the Power Unit

Pressing the Power Unit softkey allows you to select either W, dB, or dBm as the units in which power is displayed. The Power Unit softkey is visible when you

move to the [*P*] or [*Ref*] parameters. alternatively the Power Unit can be changed by using the Power Meter menu.

## What are the Power Units ?

Watts (W) are the SI unit for power measurement.

You can also measure power in dB or dBm. Values displayed in these units are derived from measurement in Watts.

By selecting dBm, the following calculation is made:

$$P_{dBm} = 10\log\frac{P_{input}\ (W)}{1 \times 10^{-3}(W)}$$

Where,

$P_{dBm}$ is the power value displayed in dBm, and

$P_{input}$ is the input signal level in Watts.

Power, in units of dBm, is measured relative to 1 mW, it is an absolute power measurement.

By selecting dB, the following calculation is made:

$$P_{dB} = 10\log\frac{P_{input}(W)}{P_{ref}(W)}$$

Where,

$P_{dB}$ is the power value displayed in dB,

$P_{input}$ is the input signal level in Watts, and

$P_{ref}$ is the chosen reference power value in Watts.

Power, in units of dB, is measured relative to a particular reference power value. For information on selecting this reference value, see *"How to Input a Reference Level" on page 74.*

To set the power unit to dBm:

1 Move to the [*P*] parameter and press the [Power Unit] softkey. You will see the menu in Figure 39.

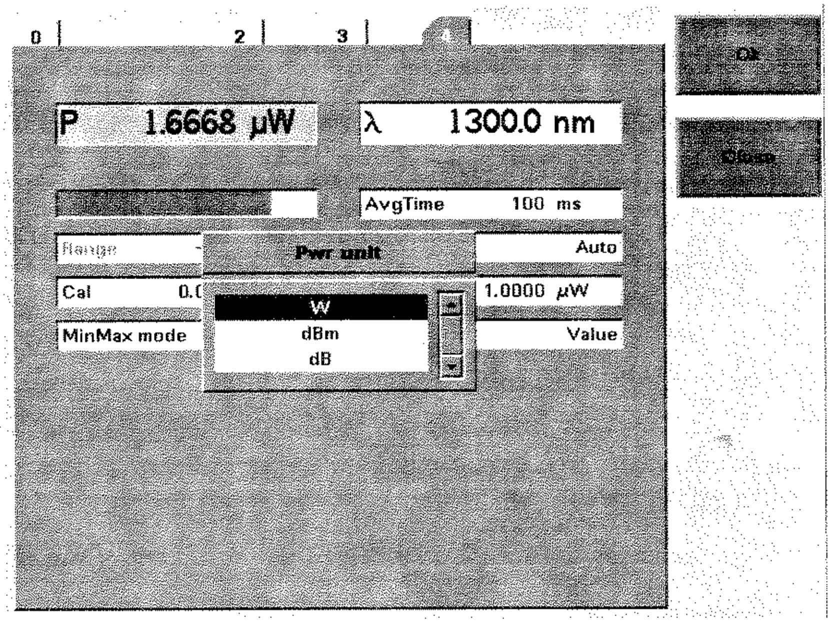



**Figure 39** **Selecting the Power Unit**

2 Move to <*dBm*>, by using the cursor key, and press *Enter*.

# How to Set the Calibration Offset

This is a calibration offset that you can enter to compensate for external optical circuitry, for example, the HP 81022FF Integrating Sphere or a 3 dB coupler. The calibration offset, [*Cal*], is automatically subtracted from the input signal.

$P_{measured}(dBm) = P_{input}(dBm) - CAL(dB)$

Where,

| | |
|---|---|
| $P_{measured}$ | is the adjusted value of the signal read in dBm, |
| $P_{input}$ | is the input signal level in dBm, and |
| *CAL* | is the calibration offset in decibels (dB). |

To set the calibration offset to 40.000 dB:

1 Move to the Power Meter channel and press the [Details] softkey.

2 Move to the [*Cal*] parameter and press *Enter.*

3 Enter 40.000 and press *Enter*.

# How to Set the Reference Level

## How to Input a Reference Level

dB results are shown relative to a reference level. The [*Ref*] parameter sets the reference level. Setting, or changing, the reference only affects results that are displayed in dB.

The reference level is displayed in units of dBm or Watts. Depending on which is selected the following equations are used to calculate the power level in dB:

$P_{display}(dB) = P_{measured}(dBm) - REF(dBm)$

or

$$P_{display}(dB) = 10\log\frac{P_{measured}(W)}{REF(W)}$$

Where,

- $P_{display}$ is the displayed relative power,
- $P_{measured}$ is the absolute power level (see *"How to Set the Calibration Offset" on page 73*), and
- $REF$ is the reference level.

You can choose the units for the reference using the Power Unit softkey. If you choose dB, the power value changes to dB and the displayed reference level changes to dBm.

To set the reference level to 10 mW:

1. Move to the Power Meter channel and press the [Details] softkey.
2. Move to the [*Ref*] parameter and press the [Power Unit] softkey.
3. Move to <*W*> and press *Enter* twice.
4. Change the units to mW using the [Unit+] and [Unit–] softkeys.
5. Enter 10.000 and press *Enter*.

## How to Set the Reference Value to the Current Power Value

In addition to entering a new reference value, you can change the reference value to the currently displayed power value by pressing the [Dsp->Ref] softkey.

Pressing the [Dsp->Ref] softkey takes the input power level and stores it as the reference. Setting the reference only affects results displayed in dB.

When you press the [Dsp->Ref] softkey, the absolute power level, the power value in dBm or Watts, is stored as the reference, that is:

$REF = P_{measured}$

Where,

REF is the reference, and

$P_{measured}$ is the absolute power level (see *"How to Set the Calibration Offset" on page 73*).

The [Dsp->Ref] softkey is displayed if you move to a power measurement channel.

## How to Reference Another Power Measurement Channel

You can use the reference mode, [*Ref Mode*], to reference another Power Meter's current power level. If you choose this mode, the reference of the channel continuously updates to the current power value measured by the other channel.

The following equations describe how the power in dB is calculated if you reference another channel:

$$P_{display}(dB) = P_{measuredA}(dBm) - P_{measuredB}(dBm) - REF(dB)$$

or

$$P_{display}(dB) = 10\log\frac{P_{measuredA}(W)}{P_{measuredB}(W)} - REF(dB)$$

Where:

$P_{display}$ is the displayed relative power,

$P_{measuredA}$ is the absolute power level (see *"How to Set the Calibration Offset" on page 73*) measured by the current Power Meter, and

$P_{measuredB}$ is the absolute power level (see *"How to Set the Calibration Offset" on page 73*) measured by the Power Meter you choose to reference, and

*REF* is the reference level in decibels (dB).

**NOTE** You can only set the reference level, *REF*, in decibels (dB) when you reference Power Meter's current power level. This reference level is stored in separate memory than the absolute reference level.

To reference another channel:

1 Move to the Power Meter channel and press the [Details] softkey.

2 Move to the [*Ref Mode*] parameter and press *Enter*.

3 Move to the channel number you want to reference, using the cursor key, and press Enter. For example, in Figure 40, you could choose 3.1 (for channel 3.1).

Refer to *"Slot and Channel Numbers" on page 36* for information on channel numbers.

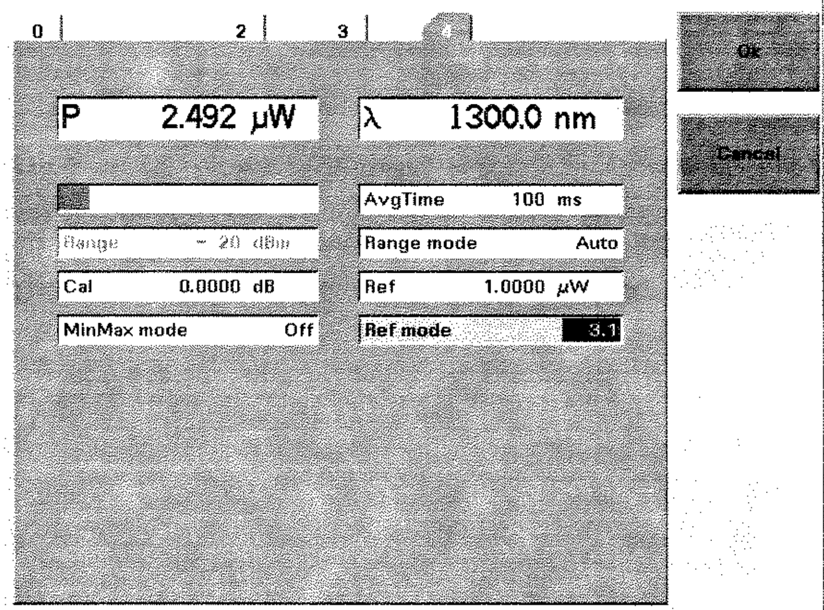



**Figure 40 Referencing Another Channel**

To return to setting a constant reference level:

1 Move to the Power Meter channel and press the [Details] softkey.

2 Move to the [*Ref Mode*] parameter and press *Enter*.

3 Move to the <*Value*> menu option and press *Enter*.

# How to Set the Wavelength

This is the wavelength value. The responsivity of the Power Meter varies with wavelength. For accurate power measurement, you need to input the wavelength of the optical input. To set the wavelength to 1545.000 nm:

1 Move to the Power Meter channel and press the [Details] softkey.

2 Move to the [λ] parameter and press *Enter*.

3 Enter 1545.000 and press Enter.

# How to Remove Electrical Offsets

Optical Power Meters measure optical power by converting optical power to electrical power, and then measuring electrical power. An electrical offset is electrical power that is always present, even if there no optical power is input. If electrical offsets are not removed, they affect the accuracy of power measurement.

Performing a zero sets the zero power level to the average electrical offset level for the current environmental conditions.

**NOTE** The environmental conditions and the temperature of the instrument affect electrical offset. For the best results you must:

- Allow the instrument time to acclimatize (around 24 hours).
- Allow the instrument time to warm up (around 20 minutes).
- Make sure that the optical input is not receiving any light. If you are using multi-mode fiber-optic cable, you must disconnect the cable and cover the input to the Power Meter to perform a zero.

It is good practice to perform a zero before making any important measurements.

To remove electrical offsets:

1 Make sure the optical input is not receiving any light. If the instrument has just been switched on, wait until SETTLING is not displayed for the module channel.

2 Move to the Power Meter channel and press the [Menu] softkey.

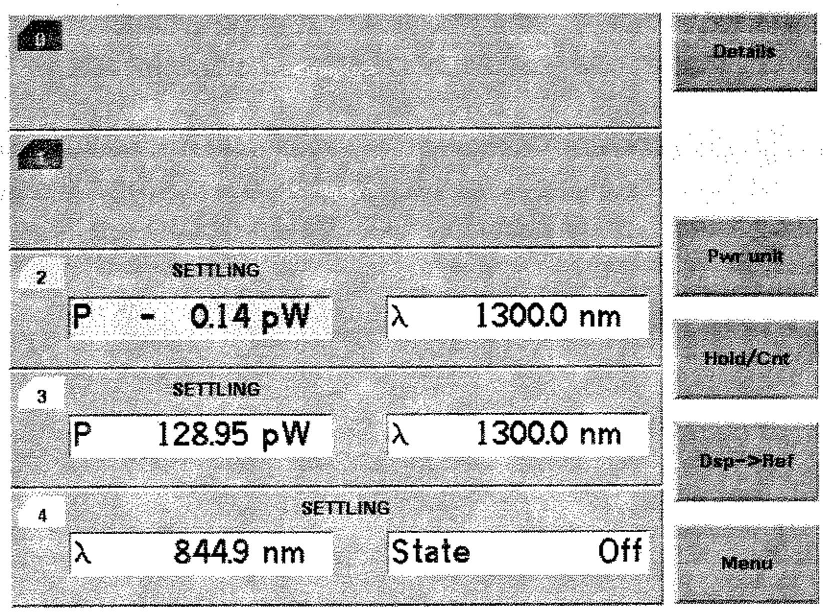



**Figure 41 Module Channels that are Settling**

3 Move to the <*Zero*> option to zero the current power measurement channel or the <*Zero All*> option to zero all power measurement channels. You will see the screen shown in Figure 42. this appears for around 30 seconds while zeroing is performed.

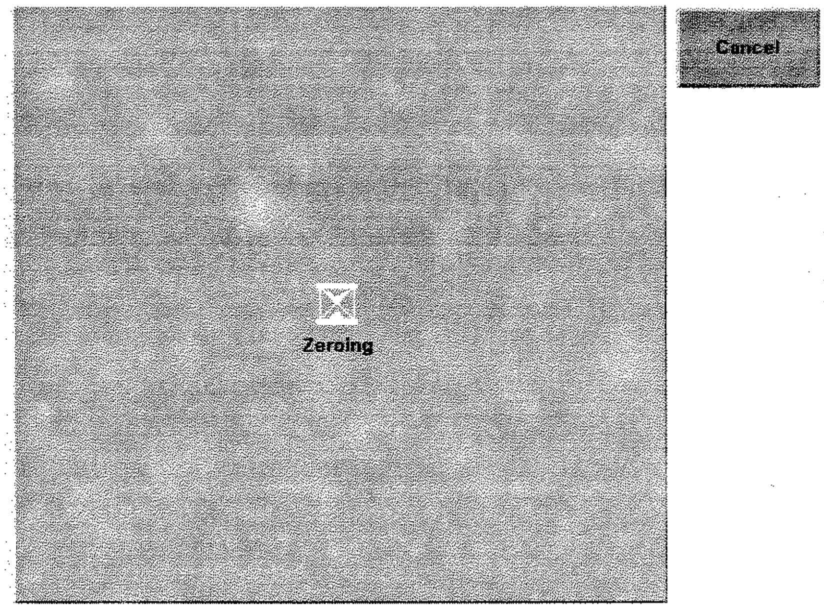



**Figure 42 Zeroing Screen**

**NOTE** If you see the screen shown in Figure 43, the zeroing operation has failed because the Power Meter received light. The most common reason for zeroing to fail is if:

- a source is connected to the Power Meter's input connector,
- the fiber connected to the Power Meter's input connector is collecting light, or
- the Power Meter receives ambient light because the input connector is uncovered.

Press *Enter* and start again at step 1.

4 When the zeroing operation finishes, press the [Close] softkey to close the menu.

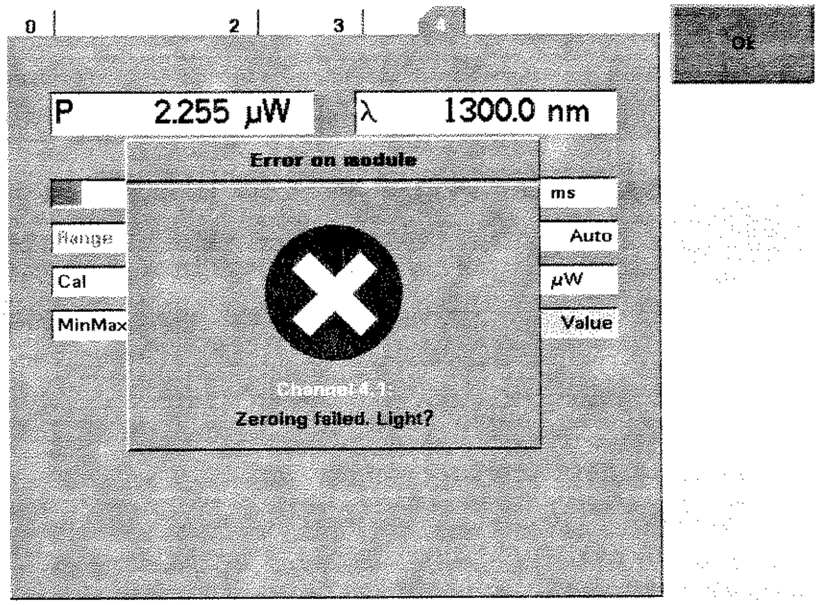



**Figure 43 Zeroing Fails, if the Power Meter Receives Input Light.**

# How to Choose the Range Mode

NOTE For a Dual Power Sensor, you cannot set the range mode of the slave channel, channel 2, directly. By default, the range mode of the slave channel, channel 2, is the same as that for the master channel, channel 1. See Table 2 on page 90 for more details.

You can choose either of two ranging modes from the Range mode menu:

- <*Auto*>, the auto-ranging mode, ensures that the result has a displayed value between 9% and 100% of full scale. The default state is for automatic ranging to be enabled.
- <*Manual*>, which allows you to set a user-defined range.

# How to Set the Range

If you choose <*Auto*> from the Range mode menu, this parameter can not be set. The Range parameter, [*Range*], is displayed in light grey text, see Figure 44, in automatic ranging mode and displays the automatically-determined range.

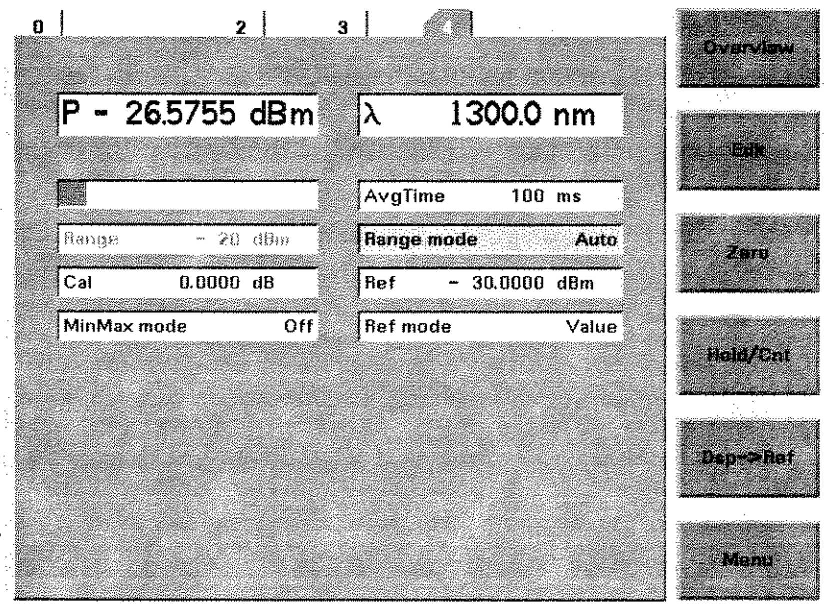



**Figure 44 Auto-Range Mode**

If you choose <*Manual*> from the Range mode menu, you must choose a range setting from the Range menu.

To choose a range setting, follow the following steps:

**1** Setup the instrument.

**2** Move to the Power Meter channel and press the [Details] softkey.

**3** Move to the [*P*] parameter and press the [Power Unit] softkey. You will see the menu in Figure 39.

**4** Move to <*dBm*>, by using the cursor key, and press *Enter*.

**5** Move to the [*Range Mode*] parameter and press *Enter*.

**6** Move to <*Auto*>, by using the cursor key, and press *Enter*.

**7** Perform a set of measurements.

**8** Note the highest [*Range*] that the instrument automatically set during this set of measurements.

**9** Move to the Power Meter channel and press the [Details] softkey.

**10** Move to the [*Range Mode*] parameter and press *Enter*.

**11** Move to <*Manual*>, by using the cursor key, and press *Enter*.

**12** Move to the [*Range*] parameter and press *Enter*.

13 Enter the range value determined in Step 8, by using the cursor key, and press *Enter*.

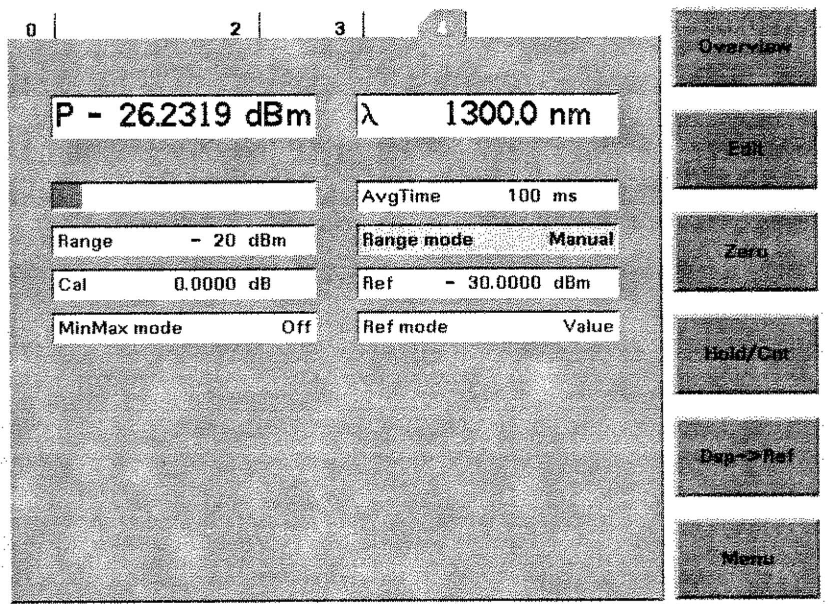



**Figure 45 Manual Range Mode - Within Range**

If the measured power is more than 3dBm greater than the range setting, it is impossible for power to be displayed. The power value, `+1.--- dBm`, as shown in Figure 46, is shown. This means that the measured power is greater than the Upper Power Limit. You must decrease the [*Range*] value.

See Table 1 on page 83 for more details.

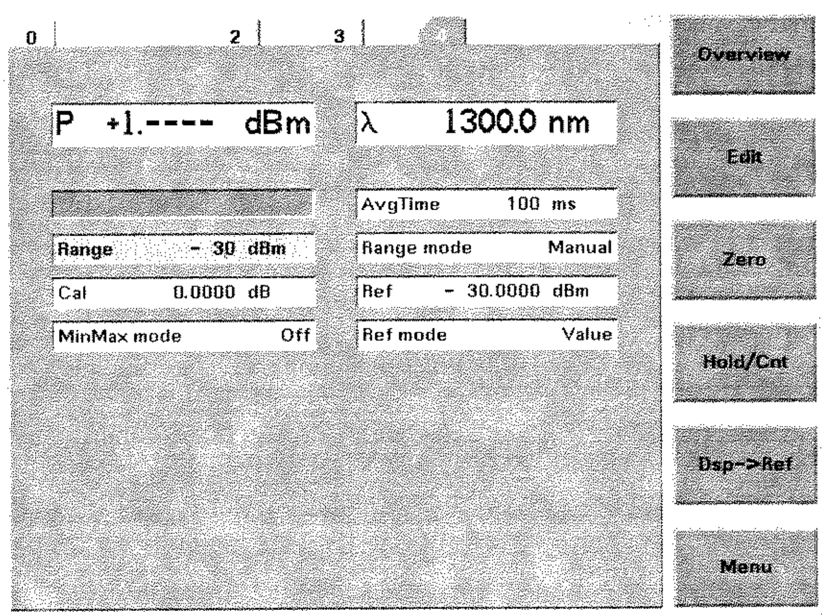



**Figure 46 Out of Range - Power Greater Than Upper Power Limit**

If the measured power is more than 40 dBm less than the range setting, it is impossible for power to be displayed. The power value, `-1.--- dBm`, as shown in Figure 47, is shown. This means that the measured power is greater than the resolution at this [*Range*] value. You must increase the [*Range*] value.

See Table 1 on page 83 for more details.

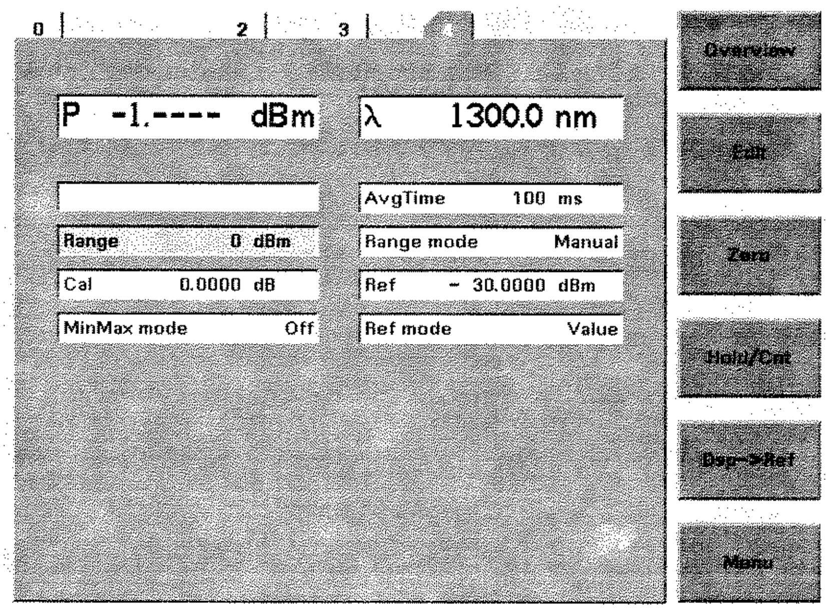



**Figure 47 Out of Range - Power Less Than Resolution**

Figure 48 shows the possible range values you can choose. These values range from 10 dBm (upper power limit of 13 dBm) to –70 dBm (upper power limit of –67 dBm) in 10 dBm increments.

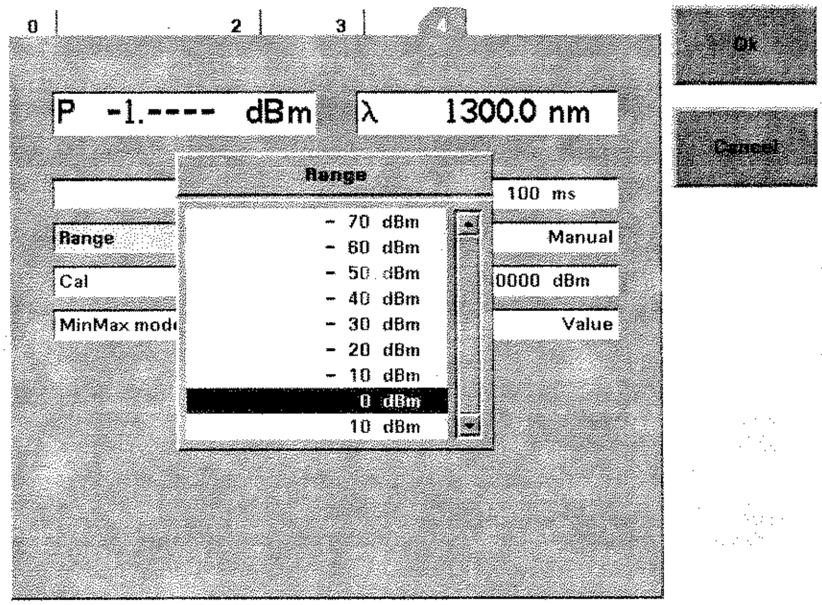



**Figure 48 Range Value Menu**

## Upper Power Limit and Resolution

Table 1 shows the upper power limit and measurent resolution at various power ranges. As can be seen the resolution decreases as the chosen [*Range*] decreases. The resolution is always 40 dBm less than the chosen [*Range*] value. The Upper Power Limit is always 3 dBm greater than the chosen [*Range*] value.

| [RANGE] | Upper Power Limit | | Resolution | |
|---|---|---|---|---|
| 10 dBm | 19.999 mW | 13.000 dBm | 0.001 mW | –30.000 dBm |
| 0 dBm | 1.9999 mW | 3.000 dBm | 0.1 µW | –40.000 dBm |
| –10 dBm | 199.99 µW | –7.000 dBm | 0.01 µW | –50.000 dBm |
| –20 dBm | 19.999 µW | –17.000 dBm | 0.001 µW | –60.000 dBm |
| –30 dBm | 1.9999 µW | –27.000 dBm | 0.1 nw | –70.000 dBm |
| –40 dBm | 199.99 nW | –37.000 dBm | 0.01 nw | –80.000 dBm |
| –50 dBm | 19.999 nW | –47.000 dBm | 0.001 nw | –90.000 dBm |
| –60 dBm | 1.9999 nW | –57.000 dBm | 0.1 pW | –100.000 dBm |
| –70 dBm | 199.99 pW | –67.000 dBm | 0.01 pW | –110.000 dBm |

**Table 1 Upper Power Limits and Resolution for Various Power Ranges**

# How to Set the Averaging Time

NOTE For a Dual Power Sensor, you cannot set the averaging time of the slave channel, channel 2, directly. By default, the averaging time of the slave channel, channel 2, is the same value as that for the master channel, channel 1. See Table 2 on page 90 for more details.

This is the length of time over which a signal is averaged. Longer averaging times increase the accuracy and improve the noise rejection. Longer averaging times also decrease sensitivity.

For averaging times of 1 second or less, a new measurement is shown at the end of each averaging time. This is drawn in Figure 49. A new measurement is shown on the display at each x.

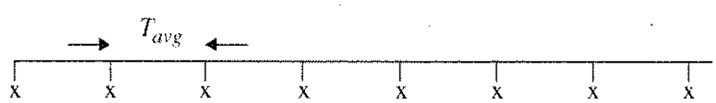



**Figure 49 Measurements with Tavg ≤ 1 second**

With modules designed for the HP 8153A Lightwave Multimeter, for averaging times of more than 1 second, the displayed power is given by the formula:

$$P_{new} = P_{old}\left(1 - \frac{T_{sample}}{T_{avg}}\right) + Sample\left(\frac{T_{sample}}{T_{avg}}\right)$$

Where,

| | |
|---|---|
| $P_{new}$ | is the new displayed result, |
| $P_{old}$ | is the previously displayed result, |
| *Sample* | is the value read by the hardware, |
| $T_{avg}$ | is the averaging time, as set by the user, and |
| $T_{sample}$ | is the time the hardware takes to make a reading. |

If the measurement condition change (for example, a range change in automatic ranging), $P_{old}$ is reset and the averaging starts again. This is why the display update seems faster in automatic ranging.

To set the averaging time to 1 second:

1 Move to the Power Meter channel and press the [Details] softkey.

2 Move to the [*AvgTime*] parameter and press *Enter*.

3 Move to <*1 s*>, by using the cursor key, and press *Enter*.

# How to Choose the MinMax Mode

NOTE For a Dual Power Sensor, you cannot set the MinMax Mode of the slave channel, channel 2, directly. By default, the MinMax Mode of the slave channel,

channel 2, is the same as that for the master channel, channel 1. See Table 2 on page 90 for more details.

MinMax mode measures the incoming power and displays the minimum value measured, [*Pmin*], and the maximum value measured, [*Pmax*]. The difference between these values, ΔP, is displayed in place of P, the power value. This mode is intended principally for polarization dependent measurements, but can be used for other types of measurement.

You can choose three modes of operation from the MinMax mode menu:

- <*Continuous*> mode, which compares each new measured value with the maximum and minimum values so far, and replaces them as necessary.
  This mode is useful for measuring the Polarization Dependent Loss (PDL) of a component. Run the application while sweeping the polarization of the source applied to the component.
- <*Window*> mode, which compares each new measured value with the maximum and minimum values of each of the previous N samples. When a new measurement is taken it is added to a buffer containing the previous N samples and the oldest measurement is deleted.
- <*Refresh*> mode, which adds each new measurement to a buffer. The minimum and maximum values, in this buffer, are displayed. After N samples are added to the buffer, the buffer resets and a new buffer is created.
  You can use Window and Refresh modes, for example, when you are searching for or setting the position of minimum PDL.

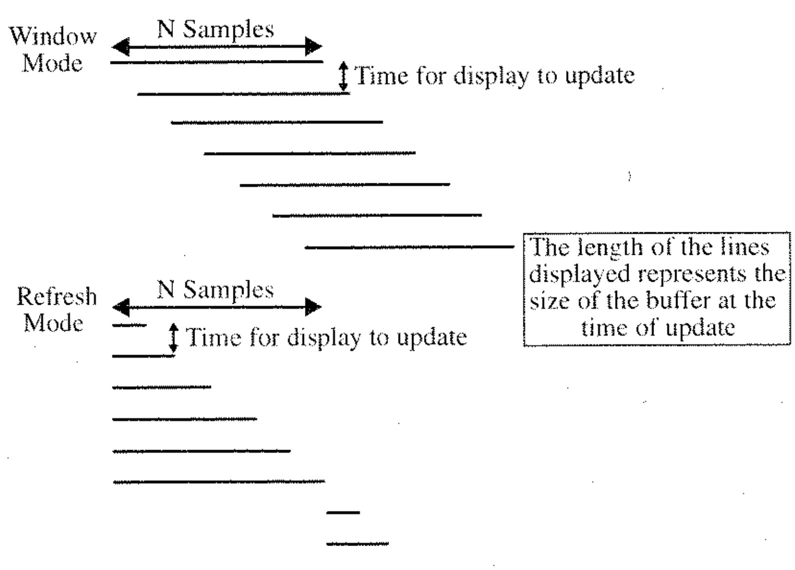



**Figure 50 The Window and Refresh Modes**

To choose the <*Refresh*> MinMax mode:

**1** Move to the Power Meter channel and press the [Details] softkey.

2 Move to the [*MinMax Mode*] parameter and press *Enter*.

3 Move to <*Refresh*>, by using the cursor key, and press *Enter*. The screen in Figure 51 appears.

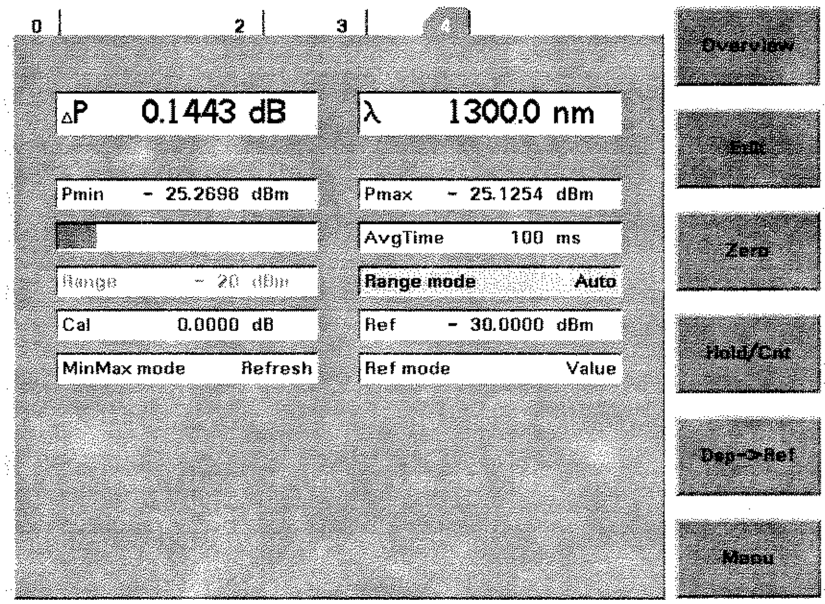



**Figure 51 MinMax Mode Screen**

4 Press *Menu*, move to <*Data Points*> and press *Enter*.

5 Enter 100 and press *Enter*.

# How to Turn Off MinMax Mode

To turn off MinMax mode, and return to continuous power measurement:

1 Move to the Power Meter channel and press the [Details] softkey.

2 Move to the [*MinMax Mode*] parameter and press *Enter*.

3 Move to <*Off*>, by using the cursor key, and press *Enter*.

# How to Hold the Screen

Pressing the [Hold/Cnt] softkey allows you to hold the screen so that no new measurements are displayed. Hold is displayed as shown in Figure 52, for the overview screen, and Figure 53, for the details screen.

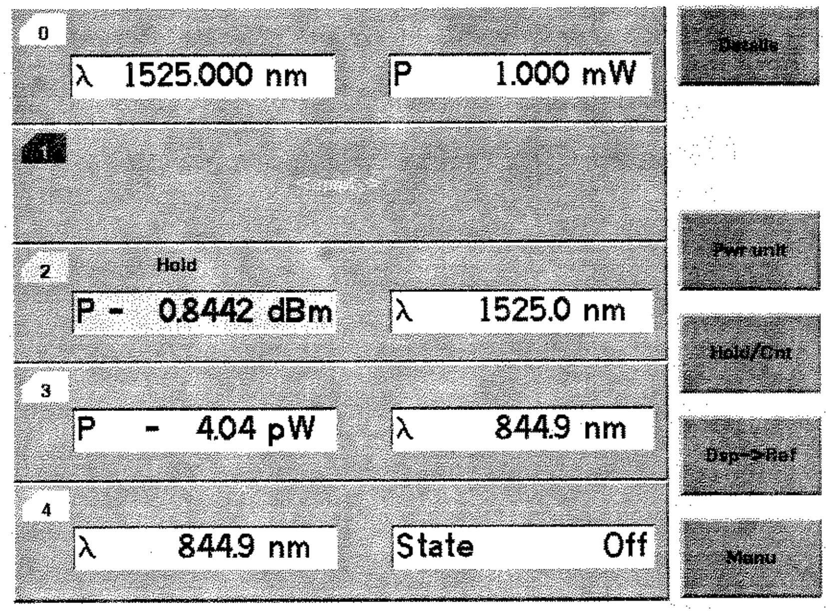



Figure 52 Power Module Channel is Held - Overview Screen

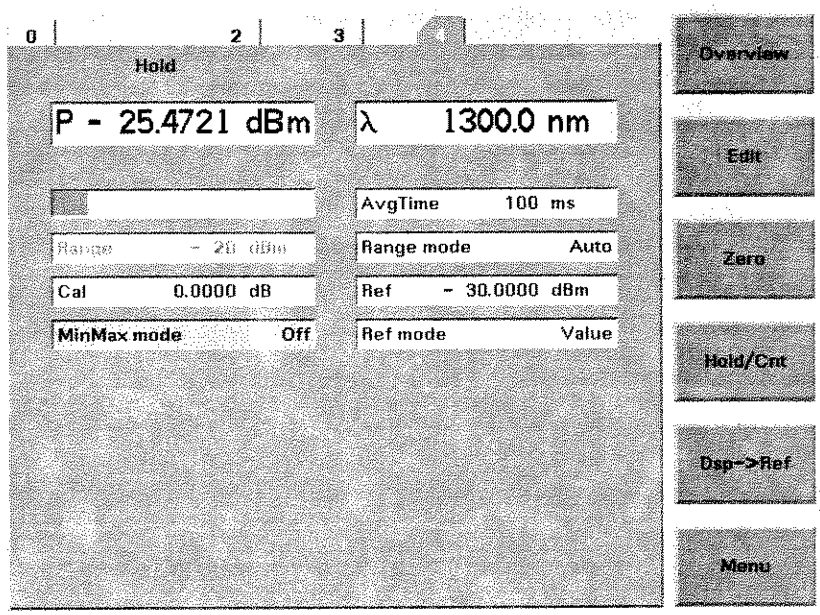



Figure 53 Power Module Channel is Held - Details Screen

By pressing the [Hold/Cnt] softkey a second time the screen will display new measurements continuously.

# How to Use Triggers

HP 8163A Series Power Meter modules allow you trigger the instrument to perform tasks and to output trigger signals to external measurement instruments.

NOTE For a Dual Power Sensor, you cannot set the any trigger parameters of the slave channel, channel 2, directly. By default, all the trigger parameters for the slave channel, channel 2, are the same as for the master channel, channel 1. See Table 2 on page 90 for more details.

## How to Trigger Power Measurements

You can configure HP 8163A Series Power Meter modules to perform certain tasks when you apply a trigger to the Input Trigger Connector.

You must prearm a measurement function before an action can be triggered:

1 See *"How to Set the Trigger Configuration" on page 62* for how to configure the trigger connectors.

2 Move to the Power Meter channel and press the [Menu] softkey.

3 Move to <*Input Trigger Mode*>, by using the cursor key, and press *Enter*. You will see the screen in Figure 54.

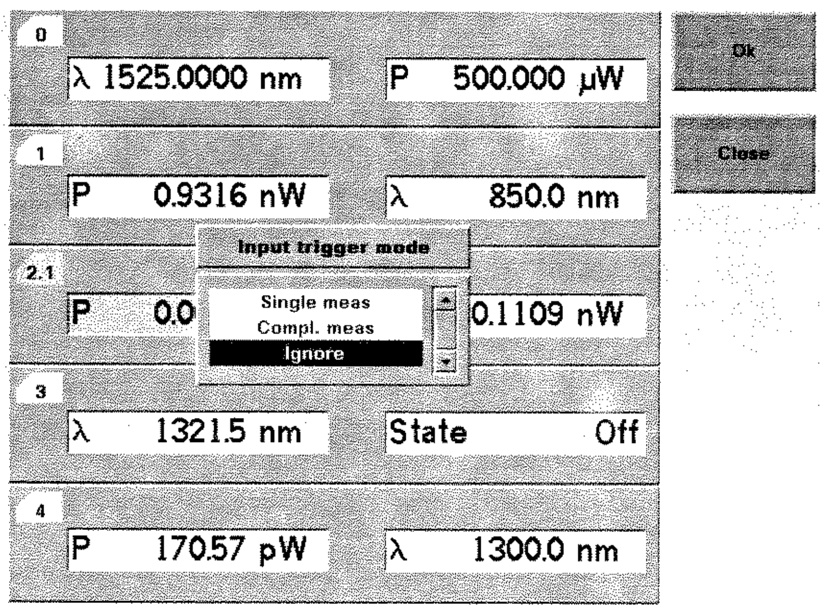



**Figure 54 Input Trigger Mode**

4 Move to one of the following, by using the cursor key:

- <*Single meas*>, an input trigger will trigger one sample of a measurement function to be performed and to store the result in a data array.
- <*Compl. meas*>, an input trigger will trigger a complete measurement function to be performed.
- <*Ignore*>, input triggers are ignored.

5 Press *Enter*.

You can generate input triggers in any of the following ways:

- trigger the Input Trigger Connector on the rear panel of your instrument.
- set <*Trigger Configuration*> to <*Loopback*> so that an output trigger automatically generates an input trigger, or
- use the `:TRIGger` GPIB command, see your mainframe's Programming Guide.

## How to Use Output Triggering

You can configure HP 8163A Series Power Meter modules to output a trigger when the instrument performs certain tasks.

To set your module's Output Trigger Configuration:

1 See *"How to Set the Trigger Configuration" on page 62* for how to configure the trigger connectors.

2 Move to the Power Meter channel and press the [Menu] softkey.

3 Move to <*Output Trigger Mode*>, by using the cursor key, and press *Enter*. You will see the screen in Figure 55.

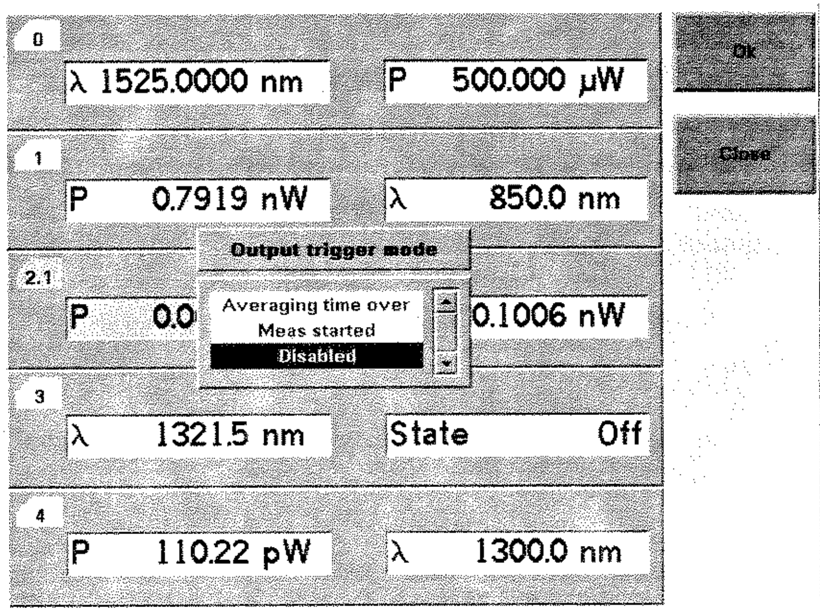



**Figure 55 Output Trigger Mode**

4 Move to one of the following, by using the cursor key:

- <*Averaging Time Over*>, a trigger is output when the averaging time period of a measurement finishes.
- <*Meas Started*>, a trigger is output when the averaging time period of a measurement begins.
- <*Disabled*>, the output trigger mode is disabled.

5 Press *Enter*.

# Dual Power Meters - Master and Slave Channels

For the HP 81635A Dual Power Sensor and the HP 81619A Dual Optical Head Interface module, channel 1 is the master channel and channel 2 is the slave channel. The master and slave channels share the same software and hardware triggering system. For some commands, setting parameters for the master channel sets the parameters for the slave channel. In these cases, you may only set parameters for the slave channel by setting master channel parameters.

The parameters listed in Table 2 can only be set or viewed using the master channel.

| Parameter |
|---|
| *<Zero>* |
| *<MinMax mode>* |
| *<Reset MinMax>* |
| *<Data points>* |
| *<Averaging time>* |
| *<Range mode>* |
| *<Input trigger mode>* |
| *<Output trigger mode>* |

**Table 2 Parameters that can only be set using the master channel**

# Laser Sources

This chapter describes how to use the HP 8163A Lightwave Multimeter, the HP 8164A Lightwave Measurement System, and the HP 8166A Lightwave Multichannel System to control fixed-wavelength laser source modules.

# How to Use Laser Source Modules

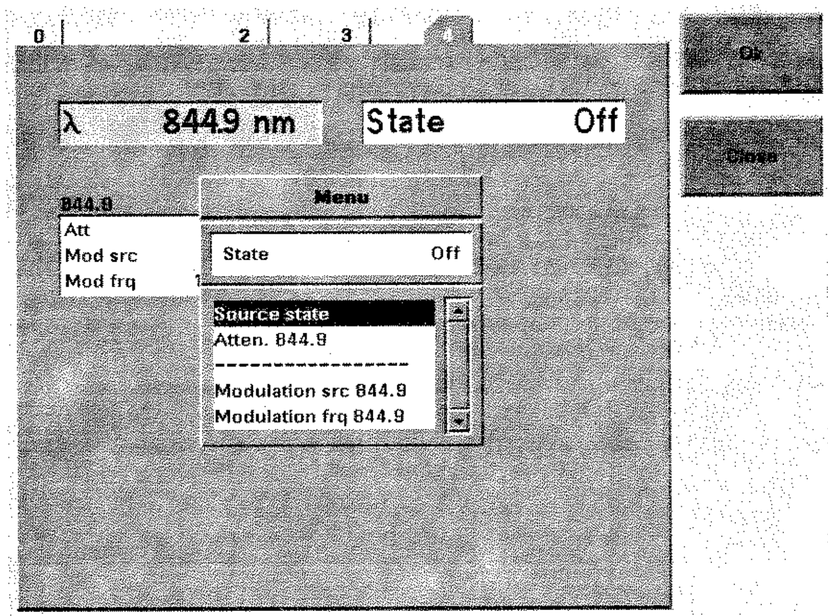



**Figure 56 Menu of Parameters for a Fixed Wavelength Laser Source**

## The Laser Wavelength Value

The laser wavelength value [λ] for a fixed-wavelength laser source module is the calibrated optical wavelength value for the laser source. This is a fixed value, you can display the value but you cannot edit it.

### Dual-Wavelength Laser Source Modules

Dual-wavelength laser source modules have optical outputs at two wavelengths. You can choose to output an optical signal at either a single wavelength or at both wavelengths simultaneously.

To choose both output wavelengths for a dual-wavelength laser source module:

1 Move to [λ] parameter and press *Enter*.

2 Select *<1309.6+1551.6>*, using the cursor key, and press *Enter*. You will see the screen in Figure 57.

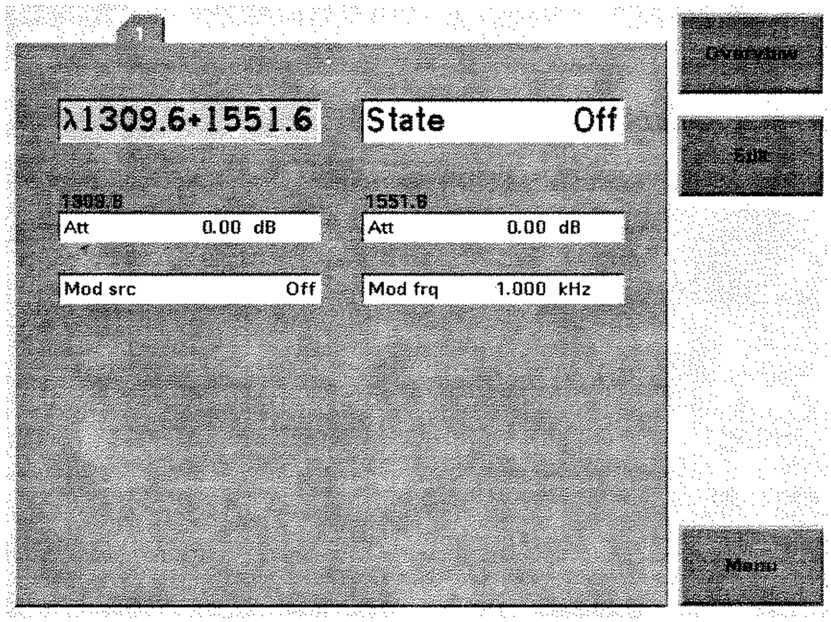



**Figure 57** **Dual-Wavelength Laser Source Outputs Both Wavelengths**

**NOTE** For further information on modulating the optical output of a dual-wavelength laser source module, see *"How to Modulate Dual-Wavelength Laser Source Modules" on page 97.*

# How to Enable/Disable Laser Output

To enable laser output using the user interface:

1 Move to [*State*] parameter and press *Enter*.

2 Move to [*On*], by using the cursor key, and press *Enter*. The green LED on the module front panel switches on.

To disable laser output using the user interface:

1 Move to [*State*] parameter and press *Enter*.

2 Move to [*Off*], by using the cursor key, and press *Enter*. The green LED on the module front panel switches off.

# How to Set Attenuation

The amount of power that is output from a source can be controlled. You can use the attenuation parameter to reduce the optical power of the laser output.

$$P_{output} = P_{source} - ATT\ (dB)$$

Where,

$P_{output}$ is the power level at the output of the module,
$P_{source}$ is the power level at the output of the source, and
ATT is the attenuation parameter.

To set the attenuation value to 2 dB:

1 Move to the laser source channel and press the [Details] softkey. You see the screen in Figure 58.

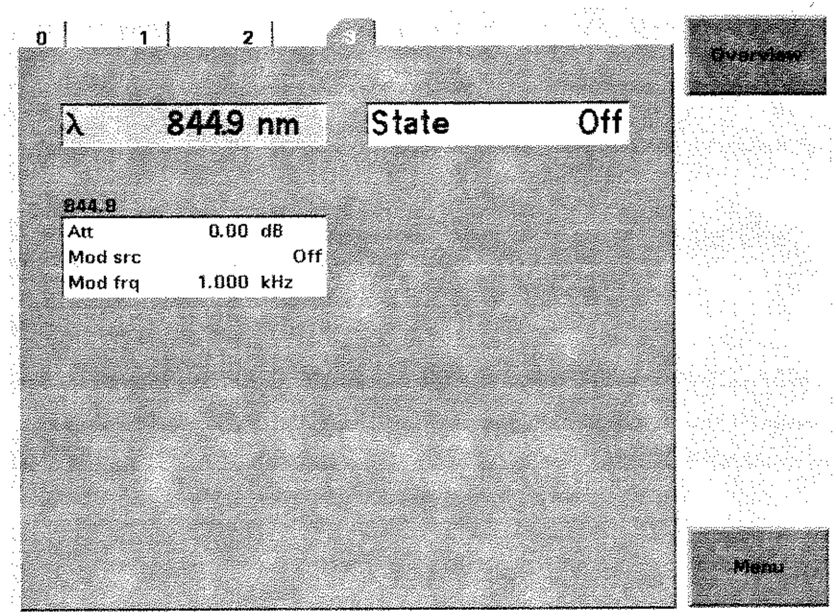



**Figure 58 The Power Sensor Details Screen**

2 Move to the [*Attenuation*] parameter and press *Enter*.

3 Enter 2.00 and press *Enter*.

# How to Modulate the Optical Output

## How to Change Modulation Source

The Modulation Source parameter, [*Mod Src*], allows you to modulate the output signal.

## How to Disable Modulation

If *<Off>* is displayed as the Modulation Source parameter, [*Mod Src*], the laser source outputs an unmodulated continuous-wave signal.

To disable modulation:

1 Move to the Laser Source channel and press [Details] softkey.

2 Move to the modulation source parameter, [*Mod Src*], and press *Enter*.

3 Move to *<Off>*, by using the cursor key, and press *Enter*.

## How to Use the Internal Modulation

The internal modulation is a square wave with a 50% duty cycle. You can set both the amplitude and the frequency of this signal. The amplitude is set by the power parameter. This is the maximum output power of the output signal; at the minimum output power, no power is output.

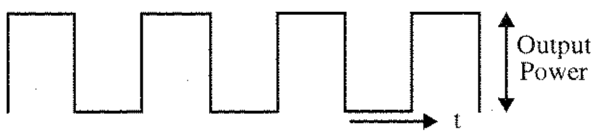



**Figure 59 The Modulated Signal**

## How to Set the Frequency of a Modulated Signal

To set the frequency of the modulation to 6.500 kHz:

1 Move to the frequency parameter, [*Mod Frq*], press *Enter*.

2 Enter 6.500 press *Enter*.

## How to Set the Modulation Mode

3 Move to the modulation source parameter, [*Mod Src*], and press *Enter*.

4 Move to *<Internal>*, by using the cursor key, and press *Enter*. The text `Int` appears in the Laser Source channel.

## How to Increase Linewidth

You can use coherence control to increase the linewidth of the optical signal output from your HP 8163A Series Laser Source module.

Enabling the coherence control increases the linewidth of the optical output signal to between 50 and 500 MHz (typically). Coherence control greatly reduces interference effects and therefore improves the power stability in sensitive test setups.

To enable coherence control:

1 Move to the Laser Source channel and press [Details].

2 Move to [*Mod Src*] and press *Enter*.

3 Move to <*Coherence Ctrl.*>, Coherence Control, to increase linewidth to approximately 500 MHz, or move to <*Low Freq. CC*>, to increase linewidth to approximately 50 MHz.

4 Press *Enter.* The text CC or LFCC appears in the Laser Source channel depending on whether you selected <*Coherence Ctrl.*> or <*Low Freq. CC*> as the modulation source.

## How to Modulate Dual-Wavelength Laser Source Modules

NOTE You cannot modulate both wavelengths of the HP 81554SM Dual-Wavelength Laser Source module independently. If you select both wavelength outputs using the [λ] parameter, you can choose to modulate both outputs at the same frequency or to output both outputs as CW signals.

NOTE If you choose to output both wavelengths of the HP 81554SM Dual-Wavelength Laser Source and to modulate the optical output signal, the two signals may be 180° out of phase with each other.

For HP 8165x Series Dual-Wavelength Laser Source modules, you can choose independent modulation sources and independent modulation frequencies for both wavelengths.

NOTE If you choose independent modulation sources for a Dual-Wavelength Laser Source module, the text Mod will be displayed in the Laser Source channel.

If you choose the same modulation sources for both wavelengths of a Dual-Wavelength Laser Source module, the relevant text will be displayed in the Laser Source channel, for example. Int if both wavelengths use internal modulation.

To modulate the lower wavelength source at 100 kHz using internal modulation and the upper wavelength source using coherence control for a Dual-Wavelength Laser Source module:

1 Move to the laser source channel and press the [Details] softkey.

2 Move to [λ] parameter and press *Enter*.

3 Select the lower wavelength source, for example, <*1309.6*>, using the cursor key, and press *Enter*.

4 Move to the [*Mod Frq*] parameter for the lower wavelength source and press *Enter*.

5 Enter 100.000 and press *Enter*.

6 Move to the [*Mod Src*] parameter for the lower wavelength source and press *Enter*.

7 Move to <*Internal*>, by using the cursor key, and press *Enter*. The text `Mod` appears in the Laser Source channel.

8 Move to the [*Mod Src*] parameter for the upper wavelength source and press *Enter*.

9 Move to <*Coherence Ctrl.*>, by using the cursor key, and press *Enter*. The text `Mod` is still displayed in the Laser Source channel.

10 Enable the laser output, by pressing the *Active* hardkey on the module's front panel.

# How to Use Triggers

Some Laser Source modules allow you to output trigger signals to external measurement instruments.

## How to Use Output Triggering

You can configure the output trigger connector to output a TTL signal at the frequency of the internal modulation of a HP 8163A Series Laser Source module.

To set your module's Output Trigger Configuration:

1 See *"How to Set the Trigger Configuration" on page 62* for how to configure the trigger connectors.

2 Move to the Laser Source channel and press [Menu].

3 Move to <*Output Trigger Mode*>, by using the cursor key, and press *Enter*. You will see the screen in Figure 60.

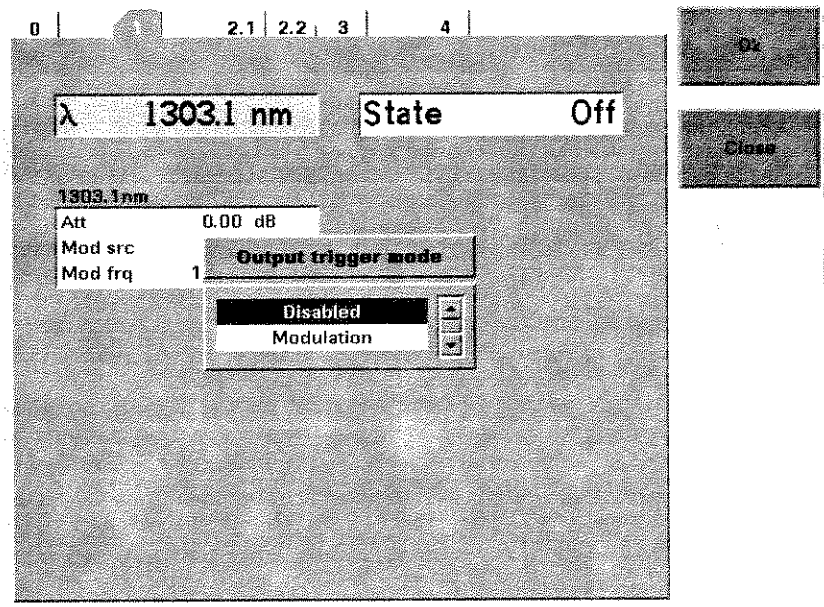



**Figure 60 Output Trigger Mode**

4 Move to one of the following, by using the cursor key:

- <*Disabled*>, the output trigger mode is disabled.
- <*Modulation*>, the output trigger connector outputs a TTL signal at the frequency of the internal modulation. This signal is output whether the laser is switched on or off.

5 Press *Enter*.

# Tunable Lasers

This chapter explains how to control Tunable Laser modules from the user interface of the HP 8163A Lightwave Multimeter, the HP 8164A Lightwave Measurement System, and the HP 8166A Lightwave Multichannel System.

# What is a Tunable Laser ?

A tunable laser is a laser source for which the wavelength can be varied through a specified range. The Hewlett-Packard Tunable Laser modules also allow you to set the output power, and to choose between continuous wave or modulated power.

# How to Set the Power

The laser output can be either:

- a continuous wave (CW) signal, fixed amplitude signal, see *"How to Set the Output Power of a CW Signal" on page 104*,
- a modulated signal, see *"How to Modulate a Signal" on page 119*, or
- a signal with increased linewidth (coherence control), see *"How to Increase Linewidth" on page 124.*

If [*Mod Src*] is <*Off*>, a continuous wave signal is the chosen optical output. A continuous wave signal is the default.

If any other [*Mod Src*] source is chosen, the chosen source modulates the signal. For possible modulation sources, see *"How to Modulate a Signal" on page 119.*

Attenuator

**If your tunable laser has an built-in optical attenuator, you can choose one of the two following power modes:**

- **<*Automatic*> Attenuation Mode, you specify the output power and the instrument automatically sets the optical output power by using the optimum combination of laser diode current and optical attenuation, or**
- **<*Manual Att.*> Mode, you specify the output power and the attenuation.**

**The two modes are separate, the values set in one mode do not affect values set in the other.**

# How to Set the Output Power of a CW Signal

## How to Set Output Power

To set the output power to 555.000 µW:

Attenuator **If your tunable laser has an built-in optical attenuator, move to [*Power Mode*], press *Enter*, move to <*Automatic*>, and press *Enter*.**

1 Move to the power parameter, [*P*], and press [Pwr unit].

2 Move to <W> and press *Enter*.

3 Press *Enter* to start editing the output power value.

4 Enter 555.000, press [Unit+] or [Unit−], as required, to select µW as the power units. and press *Enter*.

## How to Set the Optical Output

To set the Optical Output of a Tunable Laser module with two optical outputs:

1 Press [Details].

2 Move to [*Optical Output*] and press *Enter*.

3 Use the Modify Knob to move to one of the following:

- <*High Power (2)*>, a high power optical output, for example, for use in tesing Erbium Doped Fiber Amplifiers (EDFAs), you see a screen similar to Figure 61,
- <*Low SSE (1)*>, a lower power optical output with low Source Spontaneous Emission (SSE), for example, for use in passive component test, you see a screen similar to Figure 62,
- <*Both (master:2)*>, where both optical outputs can be enabled but only the output of the high power optical output can be regulated, and
- <*Both (master:1)*>, where both optical outputs can be enabled but only the output of the low SSE optical output can be regulated.

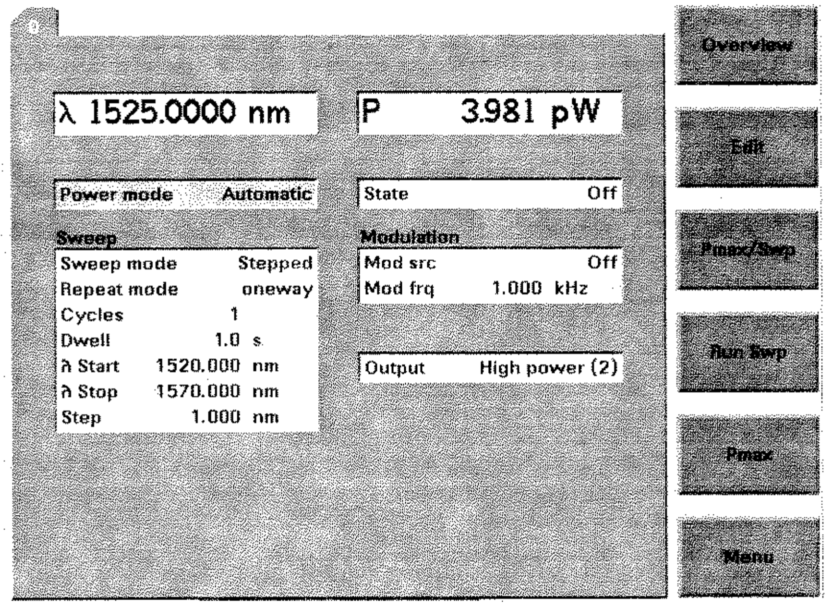



**Figure 61 Setting High Power parameters**

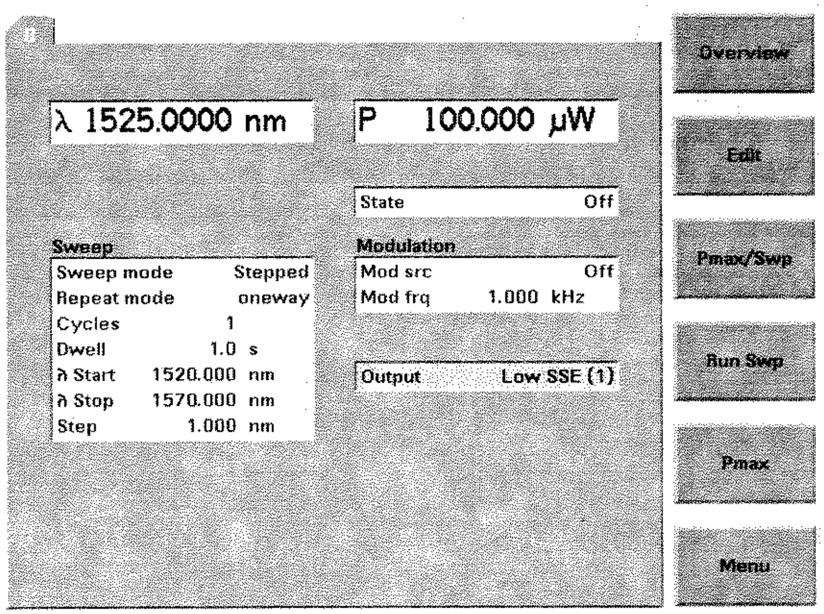



**Figure 62 Setting Low SSE parameter**

NOTE If you select <*Both (master:2)*> or <*Both (master:1)*> as the regulated path, both channels output optical power. You can only view or set the parameters for the primary optical output, for example, the high power output for <*Both (master:2)*>.

The LED beside the primary optical output is lit constantly, while the LED beside the secondary optical output flashes. For example, if you select *<Both (master:2)>* as the regulated path, the LED beside Output 2, the High Power Output, is lit constantly and the LED beside Output 1, the Low SSE optical output, flashes.

## How to Set the Optical Output

1 Move to [*Output*] and press *Enter*.

2 Move to your chosen optical output and press *Enter*.

## How to Enable the Optical Output

3 Move to [*State*] and press *Enter*.

4 Move to *<On>*, by using the cursor key, and press *Enter* to enable the output. The LED beside the optical output is lit constantly.

NOTE If you enable the laser output for a module with two optical outputs by pressing the *Active* hardkey on the module's front panel, you automatically choose the optical output for that module. For example, if you press the *Active* hardkey beside Output 1, the Low SSE optical output, you choose *<Low SSE>* as the optical output, the LED beside the Output 1 lights constantly, and you see the screen in Figure 62.

Furthermore, if you then proceed to press the ACTIVE hardkey beside Output 2, the High Power Output, you choose *<Both (master:1)>* as the optical output, the LED beside the Output 2 flashes.

If you press the *Active* hardkey beside a flashing LED, you disable the unregulated optical output. If you press the *Active* hardkey beside a constantly lit LED, you disable both optical outputs.

## How to Set Power and Attenuation

Attenuator **If your tunable laser has an built-in optical attenuator, you can set the laser output power and then set the attenuation.**

**1 Move to the Tunable Laser channel and press [Details].**

**2 Choose the Output 2, the high power output, for a Tunable Laser module with two optical outputs, as described in *"How to Set the Optical Output" on page 104*. For modules with one optical output this is not necessary.**

**3 Move to the power parameter, [P], and press [Pwr unit].**

**4 Move to <dBm> and press *Enter*.**

**5 Type 5.000, using the numerical keypad and press *Enter*.**

6 If [*Power Mode*] is not set to <*Manual Att.*> (see Figure 61), that is, it is set <*Automatic*>, perform the following steps:

   a Move to [*Power Mode*] and press *Enter.*

   b Move to <*Manual Att.*> and press *Enter.* The attenuation parameter, [*Atten.*], appears, see Figure 63.

7 Move to [*Atten.*], type 3.000, using the numerical keypad, and press *Enter*.

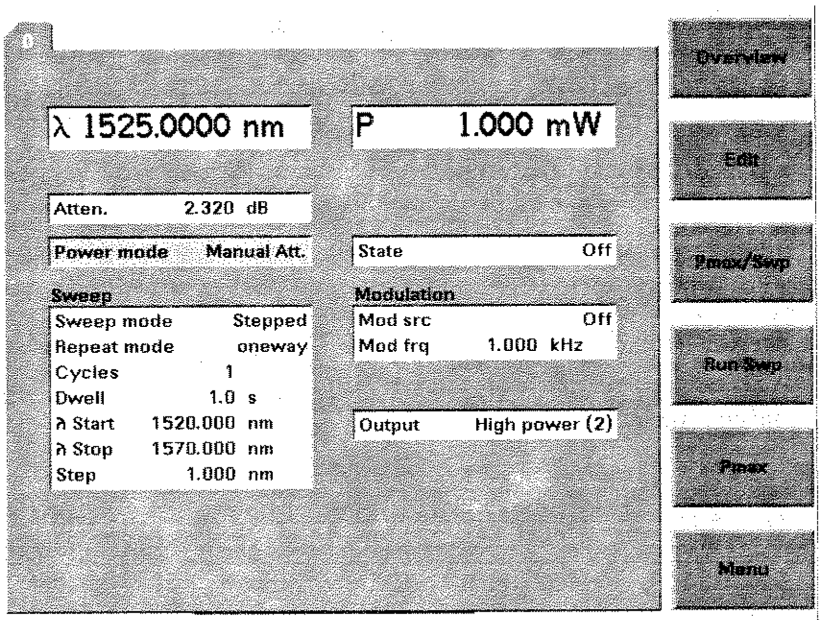



**Figure 63 Setting Attenuation**

# What is Excessive Power ?

If the text ExP is displayed in a Tunable Laser channel, see Figure 64, you have set an output power level that is larger than the laser diode can produce at the selected wavelength.

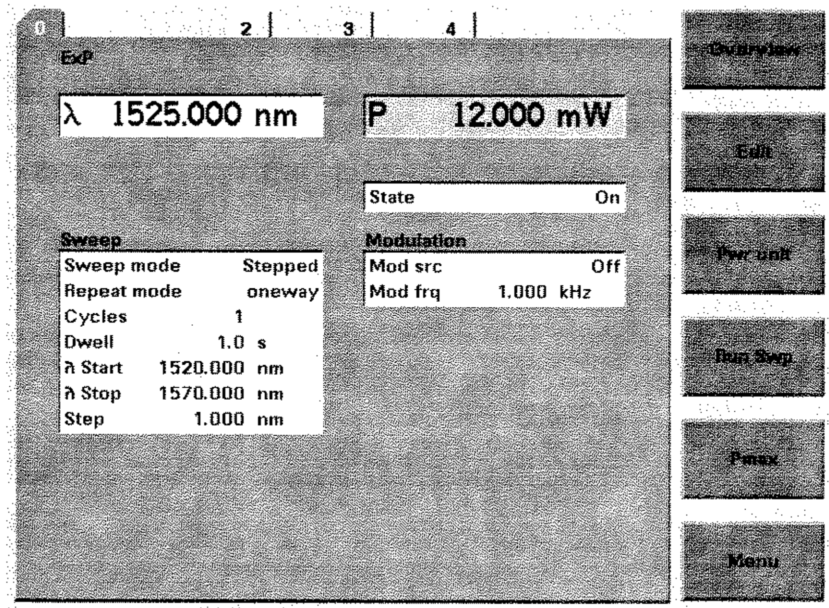



**Figure 64 Excessive Power**

To avoid this you can:

- reduce the optical output power,
- press [Pmax] to select the highest permissible power for the selected wavelength value, or
- press [Pmax/Swp] to select the highest permissible power for the selected wavelength sweep.

# How to Set the Laser to the Dark Position

Attenuator

**If your tunable laser has an built-in optical attenuator, you can use** ***<Dark position>*** **to block all laser light from the output. You can use this as an alternative to disabling the laser, the advantage of this is that you avoid the laser rise time. To enable/disable the dark position:**

1. **Move to the Tunable Laser channel and press the [Menu] softkey.**
2. **Move to the** ***<Dark position>*** **and press Enter. The Dark Position box appears.**
3. **Move to one of the following menu items:**
   - ***<On>*****, to enable the dark position, or**

- **<*Off*>, to disable the dark position**

**4 Press *Enter* to return tothe Menu screen.**

**5 Press [Close] to exit from the Menu screen.**

# The Analog Output

If there is an output BNC connector on the front panel of your Tunable Laser module, you can output a DC voltage level that is proportional to the laser output power. The relationship between this voltage level and the output power is not calibrated.

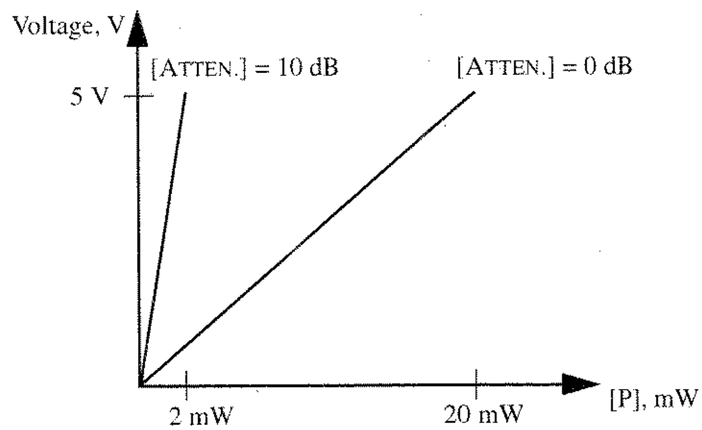



**Figure 65 Output Power and the Analog Output in <MANUAL ATT.> Mode**

Attenuator

**If your Tunable Laser module has an attenuator installed, the Analog Output signal depends on the power mode you have chosen. The voltage level is proportional to the optical power produced by the laser diode (not the optical output power).**

**In <*Manual Att.*> Mode, the relationship between the power value, [P], and the voltage level is only proportional to the output power if the attenuation remains constant. The attenuator adds a constant offset to the voltage level.**

**In <*Automatic*> Attenuation Mode, the laser output power, and therefore the Analog Output signal, is not linearly proportional to the output power. This is because the actual output optical power is derived by the optimum combination of the laser output power and the attenuation.**

To set the power to −10 dBm:

1 Move to power parameter, [P], and press [Pwr unit]. You should see the power unit menu.

2 Move to <dBm> and press *Enter*.

3 Press *Enter* to edit the power value.

4 Enter −10.000 and press *Enter*.

### How to Set the BNC Output Line Mode as an Analog Output

5 Press [Menu], move to <*BNC Output*> and press [OK].

6 Move to <*V~P*>, to choose an analog output signal, press *Enter*, and press [Close].

Attenuator **If you want to you use the analog output signal and your Tunable Laser module has an attenuator installed, it is advisable to use <*Manual Att.*> Mode and choose a constant attenuation value.**

# How to Set the Wavelength

There are three ways to set the wavelength of the Tunable Laser.

- You can set the wavelength (λ) directly,
- You can set the wavelength from a base wavelength and an offset in the frequency domain, or
- You can set a wavelength range for the instrument to "sweep".

## Wavelength Range

Every Tunable Laser module has a specified wavelength range. This range is available for all Tunable Laser modules. See Appendix C of the HP 81640A/80A/82A/89A Tunable Laser modules User's Guide to find your module's specified range.

Every Tunable Laser module has a permitted wavelength range. This range is greater than the specified range. The permitted wavelength range varies for each Tunable Laser module. You can set the wavelength to any value within the permitted wavelength range.

Figure 66 shows an example of specified and permitted wavelength range.

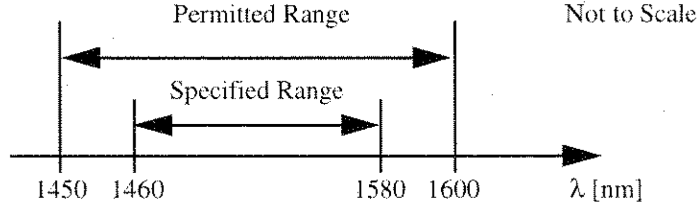



**Figure 66 Specified and Permitted Wavelength Range**

# How to Set the Wavelength Directly

You can set a constant wavelength.

To set the wavelength to 1545.500 nm:

1 Move to the Tunable Laser channel.

2 Move to the wavelength parameter, [λ], and press *Enter*.

3 Enter 1545.500 and press *Enter*.

# How to Set a Relative Wavelength

You use a relative wavelength for heterodyning, for example, when you are measuring the linewidth of DFB (distributed feedback) lasers.

The output wavelength, $\lambda$, is set from the base wavelength, $\lambda_0$, and the frequency offset, *df*. The formula for calculating the output wavelength is:

$$\lambda = \frac{c\lambda_0}{\lambda_0 df + c}$$

where c is the speed of light in a vacuum ($2.998 \times 10^8$ $ms^{-1}$).

To set a frequency offset of 1.000 THz from a base wavelength of 1545 nm:

1 Move to the Tunable Laser channel and press [Details].

2 Press [Menu]. The menu appears.

3 Move to <*Wavelength Mode*> in the menu and press *Enter*. A menu appears.

4 Move to <*Offset*>, by using the cursor key, press *Enter*, and press *Close*. You see the screen in Figure 67.

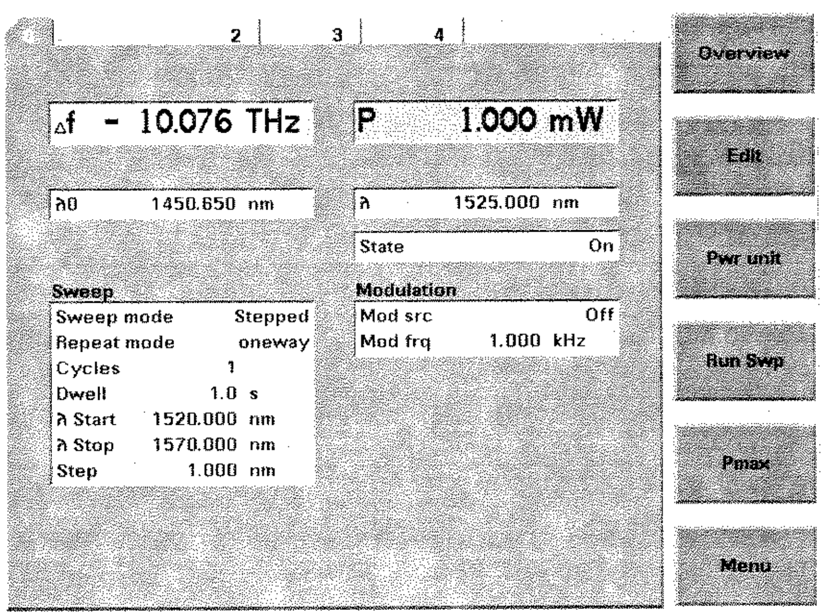



**Figure 67 Setting a Relative Wavelength**

### How to Change the Output Wavelength

5 Move to [λ] and press *Enter*. [λ] is the output wavelength, λ, in the equation above.

6 Enter 1570 and press *Enter*.

NOTE Note how the frequency offset, [Δf], changes as you change the value of [λ].

### How to Set the Base Wavelength

NOTE You cannot set <λ0>, the base wavelength directly.

7 Press [λ->*λ0*] to set <λ0> to 1570 nm. <λ0> represents the base wavelength, $\lambda_0$, in the equation above.

NOTE Note how the frequency offset, [Δf], changes to zero when you press [λ->*λ0*].

### How to Change the Frequency Offset

8 Move to [Δf] and press *Enter*. [Δf] represents the frequency offset, *df*, in the equation above.

9 Enter 1.000 and press *Enter*. The frequency offset, [Δf], changes to 1.000 THz.

NOTE Note how the output wavelength, [λ], changes as you change the value of [Δf].

# How to Perform a Wavelength Sweep

## What is a Wavelength Sweep ?

A wavelength sweep is performed when the instrument changes the optical wavelength of the optical output across a user-defined wavelength range. You can use a wavelength sweep to measure the wavelength-dependent loss of an optical component.

# How to Set the Wavelength Sweep

## The Sweep Parameters

These are the parameters for the wavelength sweep:

- [λ *Start*], the wavelength at which the sweep begins,
- [λ *Stop*], the wavelength at which the sweep ends,
- [*Step*], the size of the change in the wavelength for each step of a stepped sweep,
- [*Cycles*], the number of times the sweep is repeated,
- [*Dwell*], the amount of time spent at the wavelength during each step, for a stepped sweep
- [*Vsweep*], the speed of a continuous sweep,
- [*Sweep mode*], see *"How to Perform a Sweep" on page 114*,
- [*Repeat mode*], see *"How to Set the Repeat Mode" on page 113*.

NOTE For a <*Continuous*> sweep, [*Step*] sets the wavelength interval between output triggers, if you have set <*Output Trigger Mode*> to <*Step Finished*>, see *"How to Use Output Triggering" on page 126*.

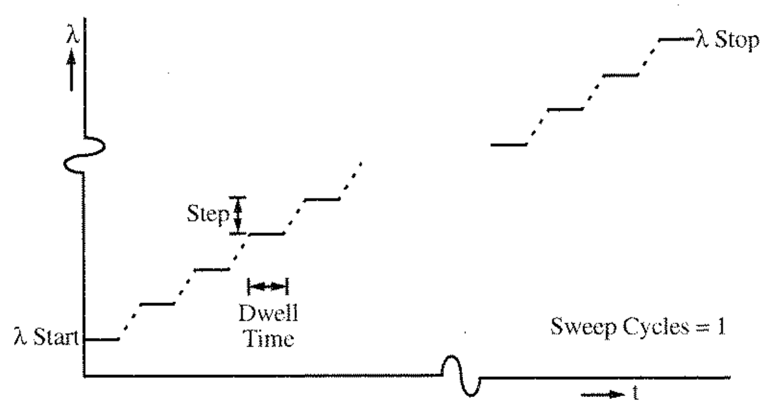



**Figure 68 The Parameters for a Stepped Wavelength Sweep**

## How to Set the Repeat Mode

The [*Repeat Mode*] determines how the instrument performs a multi-cycle sweep.

- Select <*Twoway*>, if you want to start every odd sweep cycle at [λ *Start*] and to start each even sweep cycle at [λ *Stop*].
- Select <*Oneway*>, if you want to start every sweep cycle at [λ *Start*] and to end every sweep cycle at [λ *Stop*].

Figure 69 illustrates how these modes work for a three-cycle wavelength sweep.

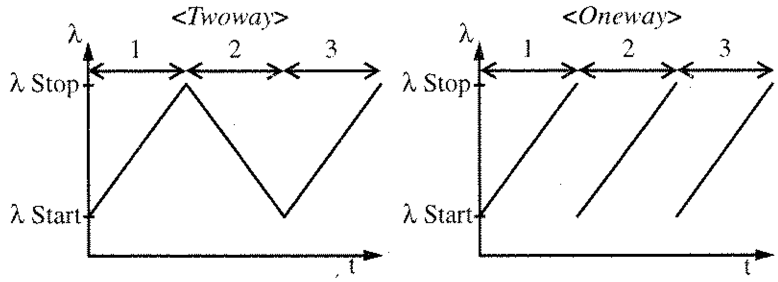



**Figure 69** **Repeat Modes**

### How to Set the Maximum Power for the Sweep Range

Pressing [Pmax/Swp] sets the power to the maximum for the selected sweep range. Alternatively, you can set a power level in the way described in *"How to Set the Output Power of a CW Signal" on page 104*. Pressing [Pmax/Swp] ensures the power will be constant for the whole sweep.

## How to Perform a Sweep

There are three sweep modes:

- <*Stepped*>, which dwells at wavelengths that are separated by a certain step size,
- <*Continuous*>, which sweeps continually at the speed you set, and
- <*Manual*>, which you can run each step manually.

NOTE You cannot turn the laser off by pressing the *Active* hardkey on the Tunable Laser front panel, while a wavelength sweep is running.

You can press [Stop] and, then, press the *Active* hardkey on the Tunable Laser front panel, to turn off the laser.

### How to Execute a Stepped Sweep

To execute a stepped wavelength sweep over the range 1510 nm to 1570 nm, three times, sweeping two ways, in 1 nm steps, stopping for half a second at each wavelength step:

1 Move to the Tunable Laser channel and press [Details].

2 Move to [*Sweep Mode*] and press *Enter*.

3 Move to the <*Stepped*> sweep mode and press *Enter*.

4 Move to [λ *Start*] and press *Enter*.

5 Enter 1510.000 and press *Enter*.

6 Move to [λ *Stop*] and press *Enter*.

7 Enter 1570.000, press *Enter*.

8 Move to [*Cycles*] and press *Enter*.

9 Enter 3 and press *Enter*.

10 Move to [*Repeat Mode*] and press *Enter*.

11 Move to <*Twoway*>, by using the cursor key, and press *Enter*.

12 Move to [*Step*] and press *Enter*.

13 Enter 1.000 and press *Enter*.

14 Move to [*Dwell*] and press *Enter*.

15 Enter 0.5000 and press *Enter*.

16 Press the [Active] hardkey on the front panel of your Tunable Laser module to enable the optical output.

17 Press [Run Swp] to start the sweep. The screen in Figure 70 appears.

18 The wavelength is swept automatically but you can:

  **a** press [Stop] to end the sweep, or

  **b** press [Pause] to pause the sweep. The screen in Figure 71 appears. You can:

    – Press [Continue] to continue sweeping automatically.

    – Press [Prev] or [Next] to sweep manually.

    – Press [Stop] to end the sweep.

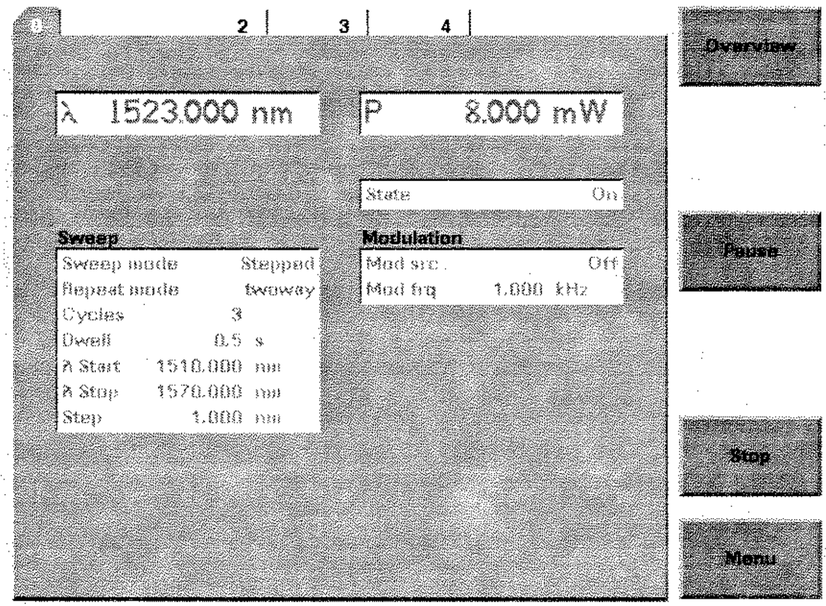



**Figure 70** **Executing a Stepped Sweep**

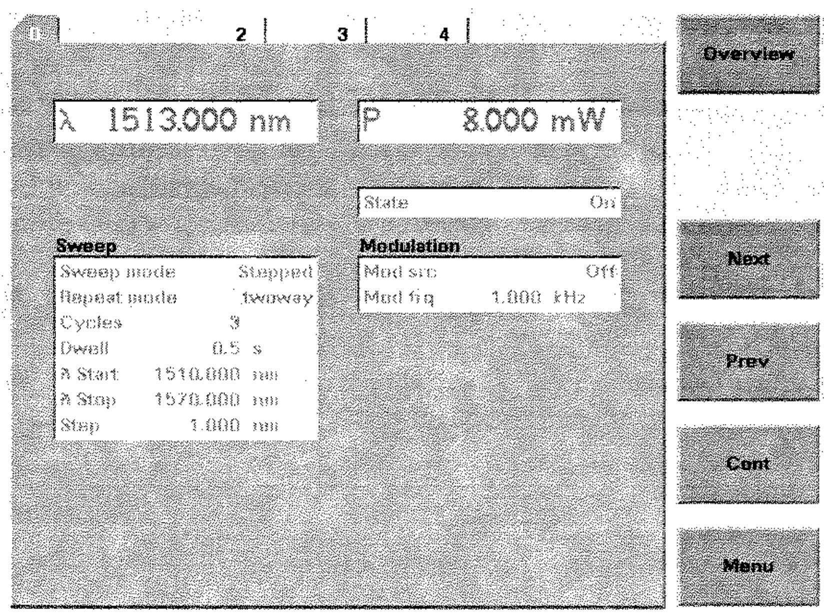



**Figure 71** **Pausing a Stepped Sweep**

## How to Execute a Continuous Sweep

NOTE Continuous sweep mode is not available for the HP 81689A Tunable Laser module.

You cannot choose a repeat mode for a continuous sweep. All multi-cycle sweeps are one-directional, see Figure 69.

To execute a continuous wavelength sweep over the range 1520 nm to 1560 nm, three times, at a speed of 5 nm/s:

1 Move to the Tunable Laser channel and press [Details].

2 Move to [*Sweep Mode*] and press *Enter*.

3 Move to the <*Continuous*> sweep mode and press ENTER.

4 Move to [λ *Start*] and press *Enter*.

5 Enter 1520.000 and press *Enter*.

6 Move to [λ *Stop*] and press *Enter*.

7 Enter 1560.000, press *Enter*.

8 Move to [*Sweep Cycles*] and press *Enter*.

9 Enter 0003 and press *Enter*.

10 Move to [*Vsweep*] and press *Enter*.

11 Move to 5 nm/s, by using the cursor key, and press *Enter*.

12 Move to [*Step*] and press *Enter*.

13 Enter 1.000 and press *Enter*.

NOTE For a <*Continuous*> sweep, [*Step*] sets the wavelength interval between output triggers, if you have set <*Output Trigger Mode*> to <*Step Finished*>, see *"How to Use Output Triggering" on page 126*.

14 Press the [Active] hardkey on the front panel of your Tunable Laser module to enable the optical output.

15 Press [Run Swp] to start the sweep.

NOTE If an error box appears displaying the text "Sweep parameters inconsistent" after you try to start a continuous wavelength sweep, one of the following cases of sweep parameter inconsistency has occurred:

- [λ *Start*] is less than [λ *Stop*].
- The sweep time is too short. Adjust [*Vsweep*], [λ *Start*], or [λ *Stop*].
- The sweep time is too long. Adjust [*Vsweep*], [λ *Start*], or [λ *Stop*].
- The trigger frequency is too high. Adjust [*Step*]. The trigger frequency is [*Vsweep*] divided by the [*Step*].
- <*Coherence ctrl.*> is the chosen [*Mod src*]. Choose another modulation source as the [*Mod src*].

16 A continuous sweep can end in two ways:

**a** when the sweep is completed, or

**b** when you press [Stop].

## How to Perform a Manual Sweep

You can perform a manual sweep if you choose the <*Manual*> sweep mode or if you press [Pause] during an automatic sweep. In a manual sweep you choose when you want to perform each step of a stepped sweep. You can choose to move forward or backward a wavelength or to end the sweep.

To perform a manual wavelength sweep over the range 1510 nm to 1570 nm, three times, sweeping two ways, in 1 nm steps:

1 Move to the Tunable Laser channel and press [Details].
2 Move to [*Sweep Mode*] and press *Enter*.
3 Move to the <*Manual*>, by using the cursor key, and press *Enter*.
4 Perform step 4 to step 13 on page 114 to set the sweep parameters.
5 Press the [Active] hardkey on the front panel of your Tunable Laser module to enable the optical output.
6 Press [Run Swp] to start the sweep. The screen in Figure 72 then appears.
7 You can:
   - press [Next] to move on to the next wavelength step,
   - press [Prev] to move on to the previous wavelength step, or
   - press [Stop] to end the sweep.

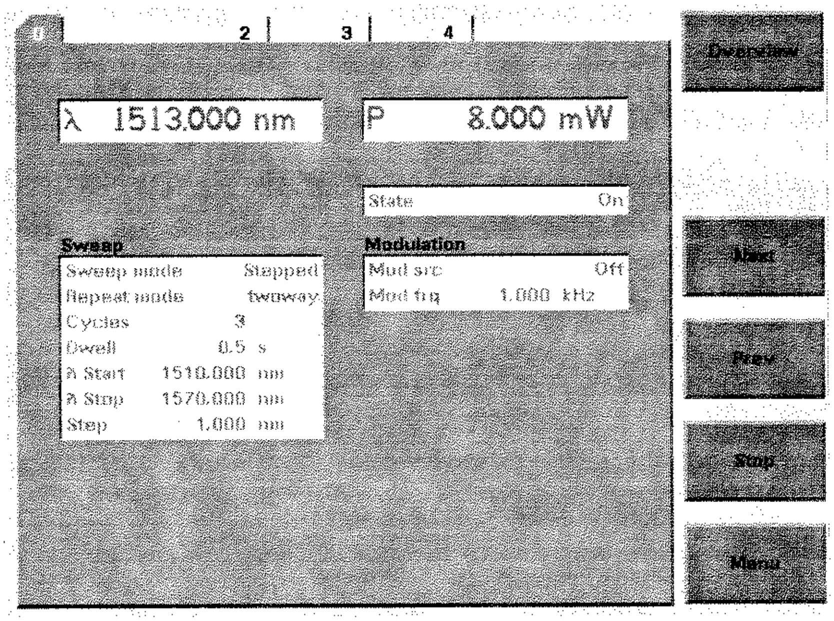



**Figure 72 Performing a Manual Sweep**

8 Perform step 6 until you choose to press [Stop].

# How to Modulate a Signal

There are two ways of modulating the amplitude of the optical output.

- Using the internal modulation, and
- using external modulation.

## How to Use the Internal Modulation

The internal modulation is a square wave with a 50% duty cycle. You can set both the amplitude and the frequency of this signal. The amplitude is set by the power parameter. This is the maximum output power of the output signal; at the minimum output power, no power is output.

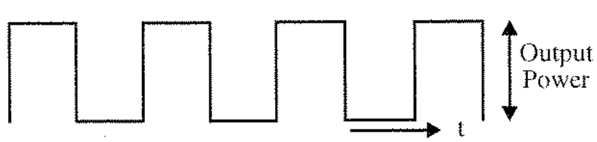



**Figure 73 The Modulated Signal**

## How to Set the Output Power of a Modulated Signal

To set the output power to 555.000 µW:

1 Move to the Tunable Laser channel and press [Details] softkey.

2 Move to the power parameter, [*P*], and press [Pwr unit].

3 Move to <*W*>, by using the cursor key, and press *Enter*.

4 Press *Enter* to start editing the output power value.

5 Enter 555.000, press [Unit+] or [Unit−], as required, to select <µW> as the power units, and press *Enter*.

## How to Set the Frequency of a Modulated Signal

To set the frequency of the modulation to 6.500 kHz:

6 Move to the frequency parameter, [*Mod Frq*], press *Enter*.

7 Enter 6.500 press *Enter*.

## How to Set the Modulation Mode

8 Move to the modulation source parameter, [*Mod Src*], and press *Enter*.

9 Move to <*Internal*>, by using the cursor key, and press *Enter*. The text `Int` appears in the Tunable Laser channel.

# How to Use External Modulation

The following external modulation modes are available:

- <*External Digital*> - External Digital Modulation
- <*External Analog*> - External Analog Modulation
- <*Wavel. Locking*> - Wavelength Locking
- <*Backplane*> - External Digital Modulation using Input Trigger connector.
- <*Coherence Ctrl.*> - Coherence Control

## External Digital Modulation

External digital modulation uses a TTL-level signal. Apply this signal to the input BNC connector on the front panel of your Tunable Laser module.

**CAUTION**

There are two BNC connectors on the front panel of the HP 81680A, HP 81682A, and HP 81640A - a BNC input connector and a BNC output connector.

There is one BNC connector on the front panel of the HP 81689A - a BNC input connector.

An absolute maximum of ±6 V can be applied as an external voltage to any BNC connector.

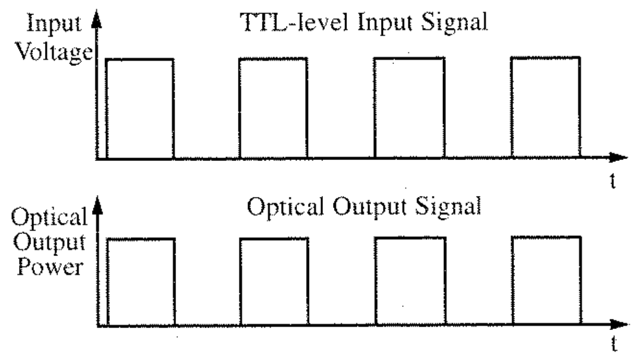



**Figure 74 External Digital Modulation**

Figure 74 shows how a TTL-level input signal modulates the optical output. Digital modulation sets the frequency of the output signal.

To set the amplitude of the output signal, set the power parameter. This is the maximum output power of the output signal; at the minimum output power, no power is output.

To enable external digital modulation:

1 Move to the Tunable Laser channel and press [Details].

2 Move to [*Mod Src*] and press *Enter*.

3 Move to <*External Digital*> by using the cursor key, and press *Enter.* The text `ExtD` appears in the Tunable Laser channel.

## External Analog Modulation

External analog modulation uses a signal of up to 5 $V_{pp}$. A 5 $V_{pp}$ signal causes 15% modulation of the power of the optical signal. Apply this signal to the input BNC connector on the front panel of your Tunable Laser module.

**CAUTION**

There are two BNC connectors on the front panel of the HP 81680A, HP 81682A, and HP 81640A - a BNC input connector and a BNC output connector.

There is one BNC connector on the front panel of the HP 81689A - a BNC input connector.

An absolute maximum of ±6 V can be applied as an external voltage to any BNC connector.

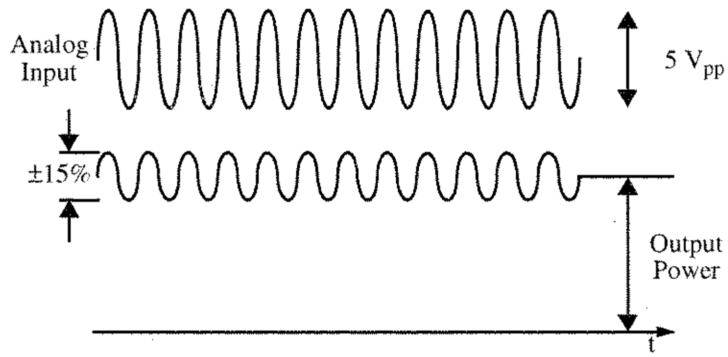



**Figure 75 External Analog Modulation and Output Power**

To enable external analog modulation:

1 Move to the Tunable Laser channel and press [Details].

2 Move to [*Mod Src*] and press *Enter*.

3 Move to <*External Analog*>, by using the cursor key, and press *Enter.* The text `ExtA` appears in the Tunable Laser channel.

## Wavelength Locking

You can choose wavelength locking as the modulation source, so the the change in output wavelength is roughly proportional to the voltage you apply to the input BNC connector on the front panel of your Tunable Laser module as shown in Figure 76. This enables you to fine tune the output wavelength within a limited wavelength range.

Wavelength locking may exhibit some hysteresis effects. The wavelength change may differ slightly when you increase voltage from when you decrease voltage.

If you modulate the input signal, the amplitude of the wavelength change of the modulated optical output reduces with increasing modulation frequency. See Appendix C of the Tunable Laser Modules User's Guide for more details.

**CAUTION**

There are two BNC connectors on the front panel of the HP 81680A, HP 81682A, and HP 81640A - a BNC input connector and a BNC output connector.

An absolute maximum of ± 6 V can be applied as an external voltage to any BNC connector.

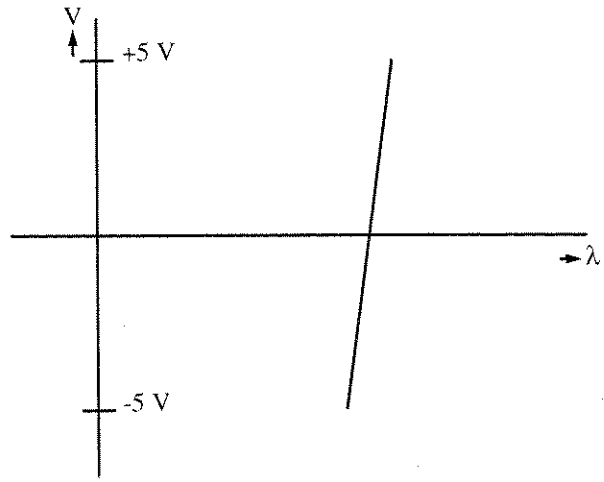



**Figure 76 Wavelength Locking**

To enable wavelength locking:

1 Move to the Tunable Laser channel and press [Details].

2 Move to <*Mod Src*> and press *Enter*.

3 Move to <*Wavel. Locking*>, by using the cursor key, and press *Enter.* The text λLock appears in the Tunable Laser channel.

## External Digital Modulation using Input Trigger Connector

External digital modulation uses a TTL-level signal. Apply this signal to the Input Trigger connector on the rear panel of your mainframe. For information on external digital modulation, see *"External Digital Modulation" on page 120.*

**CAUTION**

A maximum of 5 V can be applied as an external voltage to the Input Trigger connector, see page 217.

Take care not to use the Trigger Output connector or the Remote Interlock connector for modulation. Do not apply an external voltage to these connectors.

**NOTE** If external digital modulation using the Input Trigger Connector, <*Backplane*>, is chosen as the modulation source, [*Mod Src*], the HP 81689A Tunable Laser module behaves differently from all other modules. If the duty cycle varies:

- the average power of the output signal of the HP 81689A Tunable Laser module varies in proportion with the change in duty cycle, while,
- the power of the output signal of all other modules adjusts so that the average power of the output signal is always 50% of the set power.

To enable external digital modulation using the Input Trigger Connector:

1 Move to the Tunable Laser channel and press [Details].

2 Move to [*Mod Src*] and press *Enter*.

3 Move to <*Backplane*>, by using the cursor key, and press *Enter.* The text `Back` appears in the Tunable Laser channel.

## How to Increase Linewidth

You can use coherence control to increase the linewidth of the optical signal output from your Tunable Laser module.

Enabling the coherence control increases the linewidth of the optical output signal to between 50 and 500 MHz (typically). Coherence control greatly reduces interference effects and therefore improves the power stability in sensitive test setups.

To enable coherence control:

1 Move to the Tunable Laser channel and press [Details].

2 Move to [*Mod Src*] and press ENTER.

3 Move to <*Coherence Ctrl.*>, Coherence Control, to increase linewidth to approximately 500 MHz.

4 Press *Enter.* The text `CC` appears in the Tunable Laser channel.

## How to Set the Output Power of a Modulated Signal

All external modulation modes require you to set the output power. To set the output power, see *"How to Set the Output Power of a Modulated Signal" on page 120.*

# How to Configure the Modulation Output

If your Tunable Laser module has a BNC output connector on its front panel, to synchronize your external measuring equipment to the modulation of the module:

1 Move to the Tunable Laser channel and press *Menu.*

## How to Set the BNC Output Line Mode as a Modulation Output

2 Move to <*BNC Output*> and press [OK].

3 Move to <*Modulation*>, by using the cursor key. A TTL-level signal is output. if the optical output is digitally modulated, that is, if you choose <*Internal*>, <*External Digital*>, or <*Backplane*> as the chosen modulation source. The output signal has the same frequency as the optical output.

4 Press [OK].

### How to Set the Modulation Output Mode

5 Move to *<Modout>* and press [OK].

6 Move to either of the following two menu items, by using the cursor key:

- *<FRQ&RDY>*, where the modulation signal is combined with the laser-ready signal, so that the output is kept low when there is no optical signal being output, for example, when the laser is turned off or when you set the attenuator to the dark position, or
- *<FRQ>*, where the modulation signal is output all the time regardless of laser state.

7 Press [OK].

8 Press [Close] to return to the overview or detail screen.

# How to Use Triggers

Some Tunable Laser modules allow you to trigger the instrument to perform tasks and to output trigger signals to external measurement instruments.

## How to Use Input Triggering

You can configure your Tunable Laser module to perform certain tasks when you apply a trigger to the Input Trigger Connector.

**CAUTION**

A maximum of 5 V can be applied as an external voltage to the Input Trigger connector, see page 217.

Take care not to use the Trigger Output connector or the Remote Interlock connector for modulation. Do not apply an external voltage to these connectors.

To set your module's Input Trigger Configuration:

1 See *"How to Set the Trigger Configuration" on page 62* for how to configure the trigger connectors.

2 Move to the Tunable Laser channel and press [Menu].

3 Move to <*Input Trigger Mode*>, by using the cursor key, and press ENTER. You will see the screen in Figure 77.

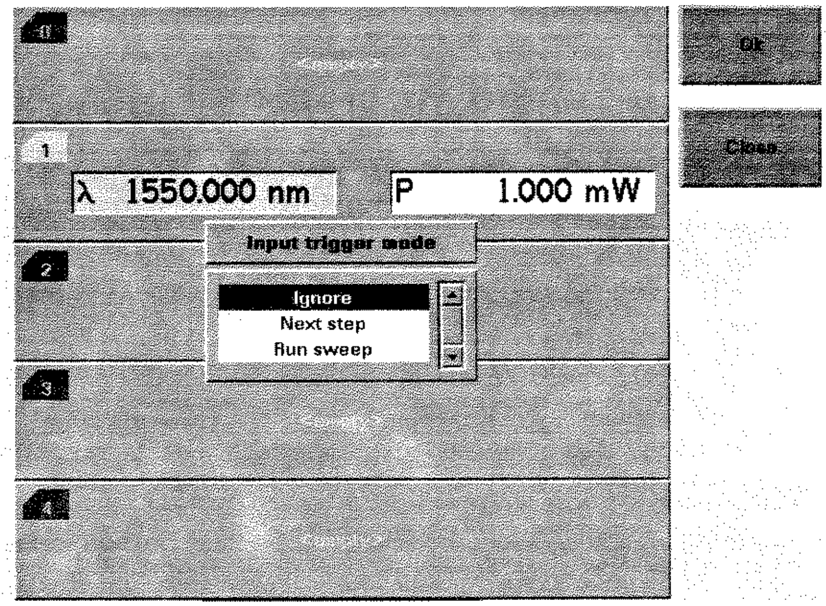



**Figure 77 Input Trigger Mode**

4 Move to one of the following, by using the cursor key:

- <*Ignore*>, input triggers are ignored.
- <*Next Step*>, an input trigger will cause the next step of a stepped sweep to be performed.
- <*Run Sweep*>, an input trigger will start a single sweep cycle.

5 Press *Enter.*

You can generate input triggers in any of the following ways:

- applying a trigger to the Input Trigger Connector on the rear panel of your instrument,
- setting <*Trigger Configuration*> to <*Loopback*> so that an output trigger automatically generates an input trigger, or
- using the `:TRIGger` GPIB command, see your mainframe's Programming Guide.

# How to Use Output Triggering

You can configure your Tunable Laser module to output a trigger when the instrument performs certain tasks.

To set your module's Output Trigger Configuration:

1 See *"How to Set the Trigger Configuration" on page 62* for how to configure the trigger connectors.

2 Move to the Tunable Laser channel and press [Menu].

3 Move to <*Output Trigger Mode*>, by using the cursor key, and press *Enter*. You will see the screen in Figure 78.

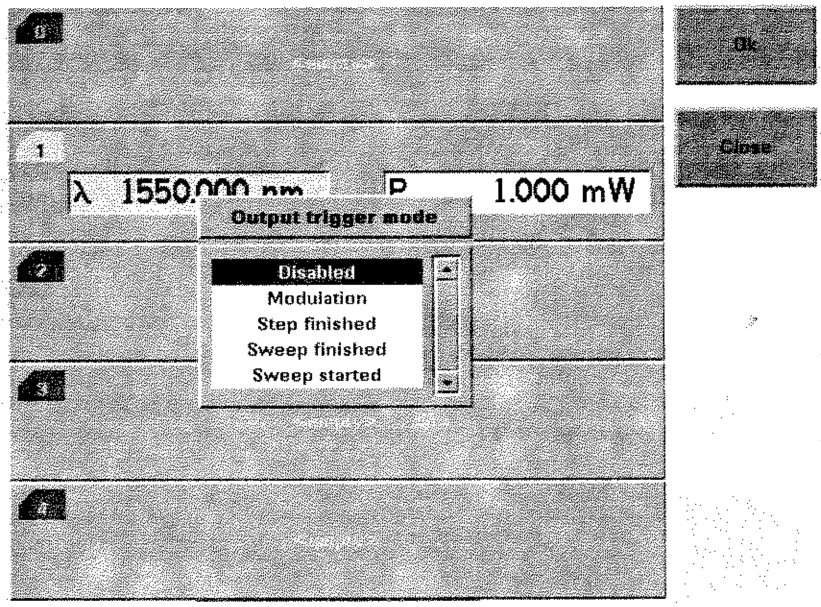



**Figure 78 Output Trigger Mode**

4 Move to one of the following, by using the cursor key:

- <*Disabled*>, the output trigger mode is disabled.
- <*Modulation*>, the output trigger connector outputs a TTL signal at the frequency of the internal modulation. This signal is output whether the laser is switched on or off.
- <*Step Finished*>, a trigger is output after every step of a sweep finishes.
- <*Sweep Finished*>, a trigger is output after a sweep cycle finishes.
- <*Sweep Started*>, a trigger is output after a sweep cycle starts.

5 Press *Enter*.

NOTE If you choose <*Step Finished*> and a <*Continuous*> sweep, the wavelength interval between hardware triggers is set by the [*Step*] parameter, although, the sweep is not stepped.

# How to Use Auxiliary Functions

## Automatic Realignment

Automatic Realignment realigns the laser cavity after Laser Protection. You should use Automatic Realignment if you have already tried to reactivate the laser and to reduce power, and this has been unsuccessful.

To realign the laser cavity:

1 Move to the Tunable Laser channel and press *Menu*.

2 Move to <*Realign*> and press [*OK*]. You will see the screen in Figure 79.

3 Wait approximately 30 minutes. This time depends on how much the wavelength of the instrument has drifted since the last Automatic Realignment was performed.

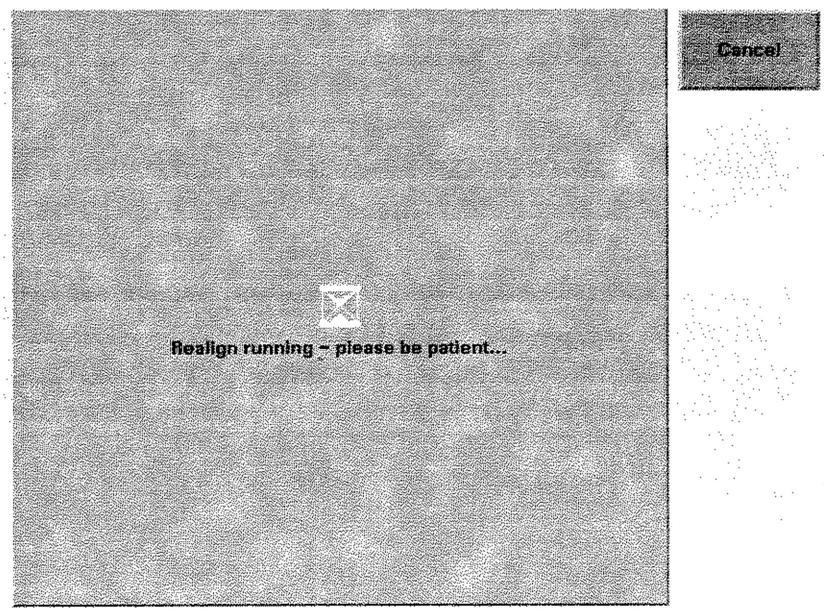



**Figure 79 Realign Screen**

## How to Perform a Wavelength Zero

Performing a Wavelength Zero recalibrates the optical wavelength. This wavelength may drift due to a change in temperature and other environmental conditions.

A Wavelength Zero is automatically performed when the instrument boots or when an Automatic Realignment is performed.

The instrument automatically performs a wavelength zero from time to time. To avoid interruption of your measurements, you should perform a wavelength zero at a time of your choice.

To perform a wavelength zero:

1 Move to the Tunable Laser channel and press *Menu*.

2 Move to <λ *Zeroing*> and press [OK]. You will see the screen in Figure 80.

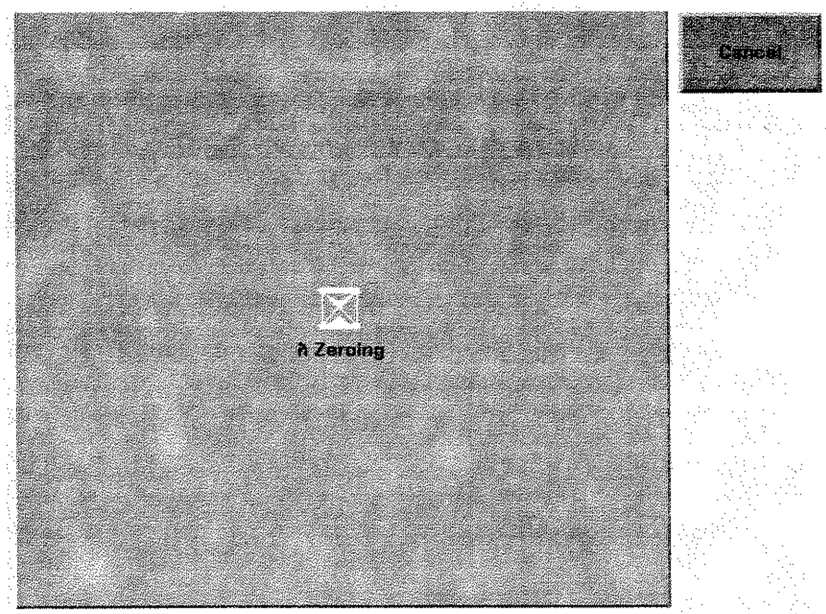



**Figure 80 λ Zeroing Screen**

3 Wait several minutes. This time depends on how much the wavelength of the instrument has drifted since the last Wavelength Zero was performed.

**NOTE** The instrument automatically performs a Wavelength Zero if there is a ± 5 K temperature change since the last Wavelength Zero was performed.

# Return Loss Measurement

This chapter explains how to use the HP 8163A Lightwave Multimeter or HP 8164A Lightwave Measurement System to measure Return Loss.

Here you will find:

- a quick explanation of the terms Return Loss and Insertion Loss,
- a description of how to measure Return Loss and Insertion Loss using the HP 81534A Return Loss module, and
- a detailed explanation of the background to Return Loss measurements using the HP 81534A Return Loss module.

# Getting Started With Return Loss

## What is Return Loss ?

When light travels through an optical component, most of it passes through, or into, the component, and some light is absorbed, scattered, or reflected by the component. In many applications the reflections are unwanted, because they can affect the emission characteristics of any laser in the system. In such applications, it is important to measure the reflections for the components of the system.

The reflection factor for a component is a measure of how much light the component reflects. It is a ratio of the power reflected by the device to the power incident on the device. More normally we talk about the return loss of a component. The return loss has units of dB. Return loss is given by:

$$Return\ Loss(dB) = -10\log(Reflection\ Factor)(dB)$$

or

$$Return\ Loss(dB) = -10\log\left(\frac{Reflected\ Power}{Incident\ Power}\right)(dB)$$

Return loss can be measured in several ways. A description of the method used by the HP 81534A follows.

The method used requires the following equipment:

- a Laser Source module with a stable output,
- a Power Meter, and
- a HP 81534A Return Loss module.

A typical setup of the HP 81534A Return Loss module is described in Figure 81.

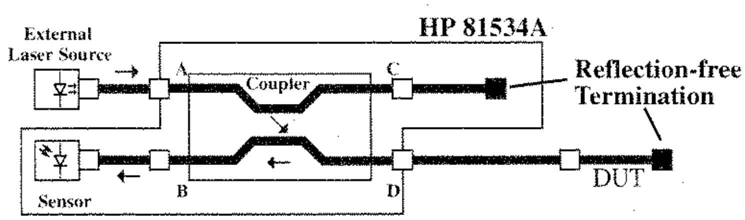



**Figure 81 Return Loss Equipment**

The description starts with measuring the reflection factor. When we have got this figure, we can convert it easily to the return loss.

# What is Insertion Loss ?

Light that is absorbed, scattered, or reflected by a component also affects how much light a component transmits.

The transmission factor for a component is a measure of how much light the component transmits. It is a ratio of the power transmitted by the device to the power incident on the device. More normally we talk about the Insertion Loss of a component. The insertion loss has units of dB. Insertion Loss is given by:

$$Insertion\ Loss(dB) = -10\log(Transmission\ Factor)(dB)$$

or

$$Insertion\ Loss(dB) = -10\log\left(\frac{Transmitted\ Power}{Incident\ Power}\right)(dB)$$

Insertion Loss can be measured in several ways. A description of the method used by the HP 81534A follows.

# How to Choose a Light Source

Highly accurate return loss measurement requires that you use a light source with a subset of the following properties:

- low coherence,
- high power, and
- power stability.

We recommend that you use any of the following laser sources as part of your return loss measurement setup:

- HP 83438A Erbium ASE Source, this source offers a high-power low-coherence output that is very stable over time,
- Laser Source modules, see *"Accessories" on page 223* for a list of modules that can be installed in your mainframe, see the note below that explains use with highly coherent light sources,
- Tunable Lasers, see *"Accessories" on page 223* for a list of modules that can be installed in your mainframe, the when you want to measure Return Loss over a wavelength range, see the note below that explains use with highly coherent light sources, and
- LED sources, the intensity of the output of LED sources is very stable over time, although the low-power output of LEDs restricts the dynamic range of return loss measurement.

NOTE If you use high-coherence light sources, you can improve performance by:

- modulating the output signal at 2 kHz or higher or
- using coherence control to reduce the coherence of the signal.

## Taking Calibration Measurements

Before measuring the reflection factor of a device under test (DUT), take some calibration measurements. These eliminate wavelength dependencies, coupler directivity, insertion losses, backscattering and other non-ideal characteristics of the system.

# How to Make Return Loss Measurements with the HP 81534A Return Loss Module

The HP 81534A Return Loss Module includes a power sensor and a coupler in one module for use in the HP 8163A Lightwave Multimeter and HP 8164A Lightwave Measurement System for the making of return loss measurements.

NOTE The HP 8166A Lightwave Multichannel System does not support the HP 81534A Return Loss Module.

NOTE We recommend that you choose an averaging time of 1 second or longer. Press [Menu], move to <*Averaging Time*>, move to your chosen averaging time, and press *Enter*.

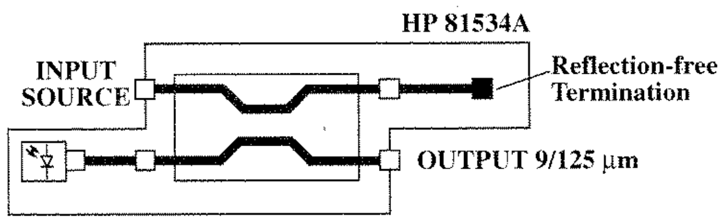



**Figure 82 The Contents of the HP 81534A Return Loss Modules**

## Calibrating a Reference Cable

The return loss setup described here uses a HP 81553SM source, inserted as a second module in the same mainframe as the return loss module.

It is recommended that you attach a patchcord to the return loss module output.

CAUTION HP supplies patchcords with a Diamond HMS-10/HP/HRL high return loss connector on one end. These patchcords are necessary so that the connector at the

output is not damaged. The full range of patchcords available are described in Table 3.

| Model No. | High Return-Loss Patchcords<br>Description |
|---|---|
| HP 81102AC | Diamond HMS-10/HP/HRL - Diamond HMS-10/HP/HRL |
| HP 81102BC | Diamond HMS-10/HP/HRL - Bare Fiber |
| HP 81102DC | Diamond HMS-10/HP/HRL - Radiall |
| HP 81102PC | Diamond HMS-10/HP/HRL - FC/APC |
| HP 81102SC | Diamond HMS-10/HP/HRL - DIN/HRL-10 |
| HP 81109AC | Diamond HMS-10/HP/HRL - Diamond HMS-10/HP |

**Table 3 High Return-Loss Patchcords**

Disturbance of the source due to reflections is reduced because the patchcord uses a high return loss connector.

The setup described uses a fiber with Diamond HMS-10/HP/HRL and Diamond HMS-10/HP connectors throughout.

1 Making sure to clean all the connectors, set up the instrument as shown in the Figure 83. Connect the source to the HP 81534A Input. Attach the high return loss connector of the patchcord to the Output. The high return loss connector on these cables is the connector with the orange sleeve. For best results and higher repeatability, fix the cables.

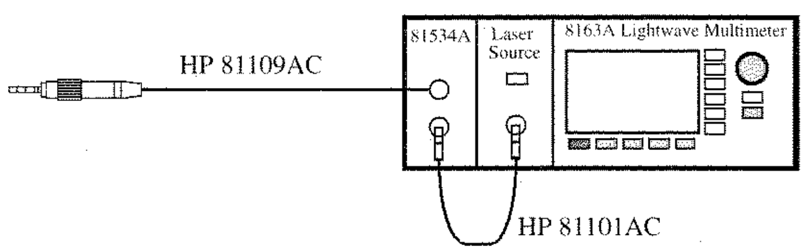



**Figure 83 Return Loss Measurement Setup**

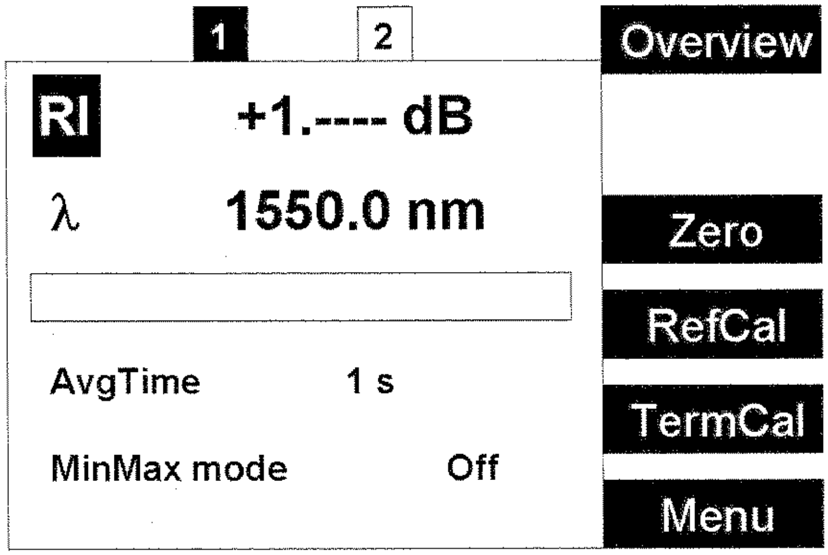



**Figure 84 HP 81634A Details Screen**

2 Make sure that the source is inactive and that you have covered the end of the patchcord to prevent light being coupled into the end. Move to the Return Loss module channel and press [Zero] to remove electrical offsets in the instrument.

3 Move to the [*AvgTime*] parameter (the measurement averaging time). Make sure that the selected averaging time is suitable for your measurements. You should use at least 200 ms, but you should increase this to at least 1 s for return losses greater than 50 dB. Longer averaging times give more accurate results, but decrease the speed at which the instrument measures.

4 Move to [λ] and set this parameter to the actual wavelength of the laser source.

5 Enable the source.

## Calibrating the Return Loss Module

To measure insertion loss and the front panel delta, see *"Calculating the Front Panel Delta" on page 149*, you must measure the return loss of a reference cable. You must first calibrate the return loss module using the HP 81000BR reference reflector. Once you have calibrated a reference cable, you can use this reference cable, in future, to calibrate the return loss module as described in *"Measuring the Reflection Reference using a Reference Cable" on page 140.*

## Measuring the Reflection Reference

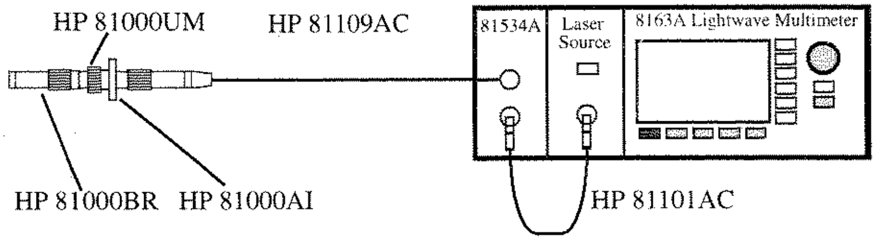



**Figure 85 Measuring the Reflection Reference**

6 Attach a component with a known return loss to the end of the patchcord as shown in Figure 85. The HP 81000BR Back Reflector is such a component, offering a return loss of 0.18 ± 0.1 dB.

7 Press [Menu] to access the menu.

8 Move to <*FPDelta*>, set the value to 0.000, and press *Enter*.

9 Move to <*RLref*> and make sure that the displayed value is correct. Set <*RLref*> to the value of the return loss of the reference reflection you are using. For example, if you are using the HP 81000BR reference reflector, set <*RLref*> to 0.18 dB.

Menu

RLref 0.180 dB

Reflectance calibration
Terminated calibration
RLref
FPDelta
Factory setting
Show calibration

OK
Close

**Figure 86 Measuring the Reflection Reference**

10 Move to <*Reflectance Calibration*> and press *Enter*. The instrument measures the power reflected by the component. The overview screen for the return loss

module appears. The <*RL*> value should be the same value as entered for <*RLref*>.

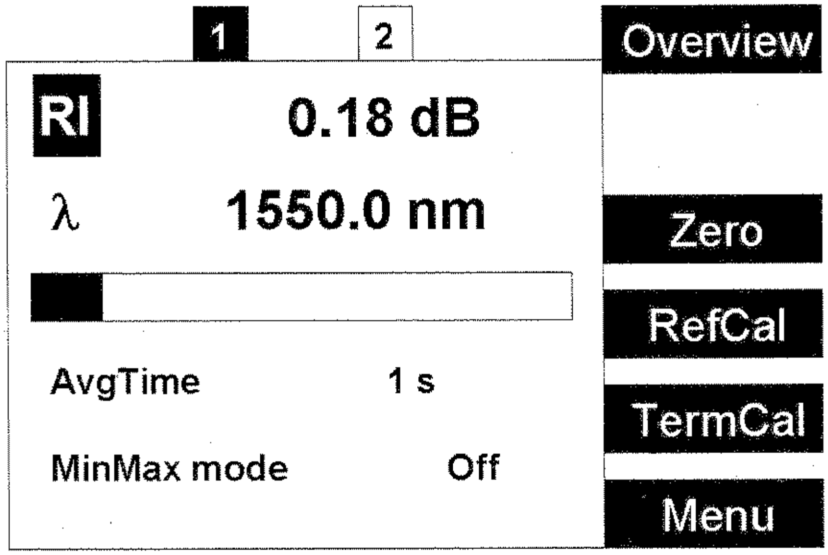



**Figure 87 Measuring the Reflection Reference**

## Measuring the Termination Parameter

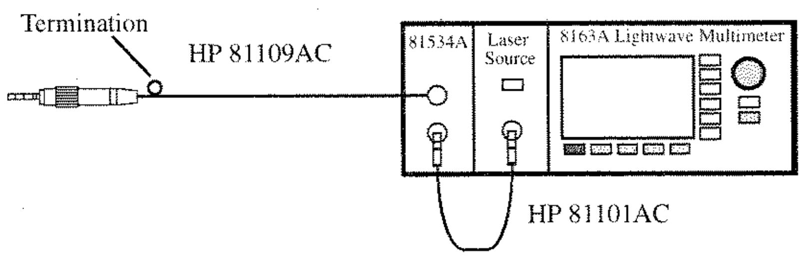



**Figure 88 Measuring the Termination Parameter**

11 Terminate the cable so that there are no reflections coming from the end. You can do this by wrapping the fiber five times around the shaft of a screwdriver (or some similar object with a diameter of around 5 mm).

12 Press [Menu]. Move to <*Terminated Calibration*> and press *Enter*. The instrument measures the power reflected by the component. The instrument measures and sets the termination parameter.

## Measuring the Return Loss of the Reference Cable

To measure insertion loss and the front panel delta, you must measure the return loss of a reference cable. The reference cable must be a fiber with a Diamond HMS-10/HP/HRL and Diamond HMS-10/HP connector.

**CAUTION** HP supplies patchcords with a Diamond HMS-10/HP/HRL high return loss connector on one end. These patchcords are necessary so that the connector at the output is not damaged. The full range of patchcords available are described in Table 3 on page 136.

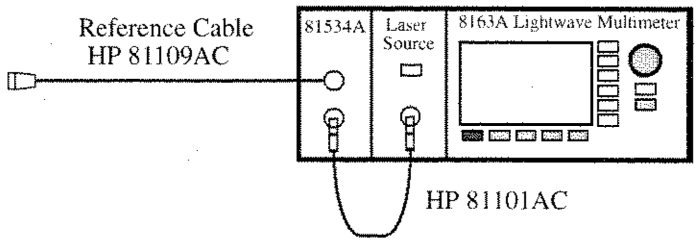



**Figure 89 Measuring the Return Loss of the Reference Cable**

13 Attach the high return loss connector of the reference cable to the Output. The high return loss connector on these cables is the connector with the orange sleeve. For best results and higher repeatability, fix the cable.

14 Record the [*Rl*] value as the return loss reference value for this cable. Attach a label to this newly-calibrated Reference Cable for future use.

# Calibrating the HP 81534A Return Loss Module using a Reference Cable

## Measuring the Reflection Reference using a Reference Cable

1 Attach the source to the HP 81534A Input as shown in Figure 89. Attach the high return loss connector of the reference cable to the Output. The high return loss connector on these cables is the connector with the orange sleeve. For best results and higher repeatability, fix the cable.

2 Press [Menu], the menu appears.

3 Move to <*FPDelta*>, set the value to 0.000, and press *Enter*.

4 Move to <*RLref*> and make sure that the displayed value is correct. If it is not, set <*RLref*> to the return loss value of the reference cable you are using.

5 Press [Menu]. Move to <*Reflectance Calibration*> and press *Enter*. The instrument measures the power reflected by the component. The <*RL*> value changes to the same value as entered for <*RLref*>.

## Measuring the Power Transmitted Through the Reference Cable

To measure insertion loss and the front panel delta, you must measure the power transmitted through the reference cable.

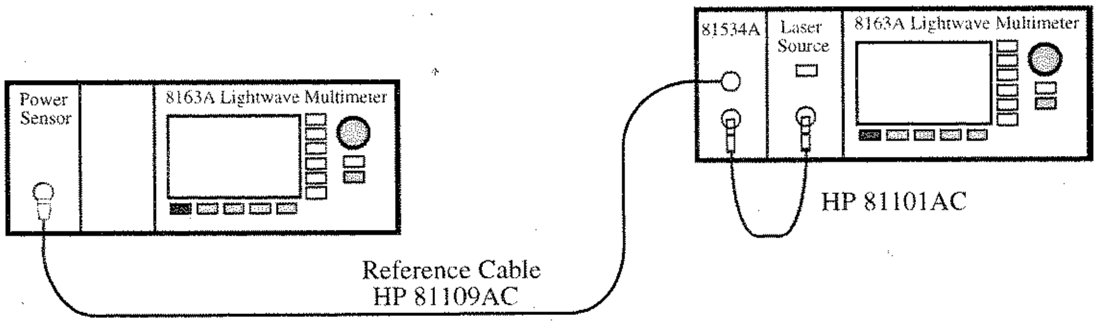



**Figure 90 Measuring the Power Transmitted through the Reference Cable**

6 Connect the reference cable to a Power Sensor as shown in Figure 90.

7 Move to the Power Sensor channel and press [Menu].

8 Move to <*Pwr unit*>, move to <*dB*> and press *Enter*.

9 Move to <*Display to reference*> and press *Enter*. This sets the power transmitted through the reference cable, $E_{Meas}$, as the reference value, [*Ref*].

10 Press [Close] to exit from the menu.

## Measuring the Termination Parameter using a Reference Cable

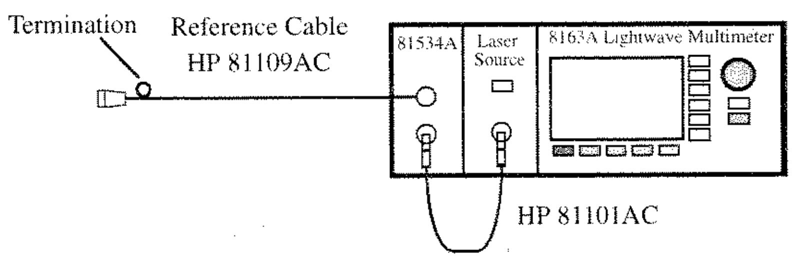



**Figure 91 Measuring the Termination Parameter**

11 Terminate the cable so that there are no reflections coming from the end. You can do this by wrapping the fiber five times around the shaft of a screwdriver *(or some similar object with a diameter of around 5mm).*

12 Press [Menu]. Move to <*Terminated Calibration*> and press *Enter*. The instrument measures the power reflected by the component. The instrument measures and sets the termination parameter.

## Measuring the Front Panel Delta

To measure the front panel delta, you must measure the power transmitted through the measurement cable.

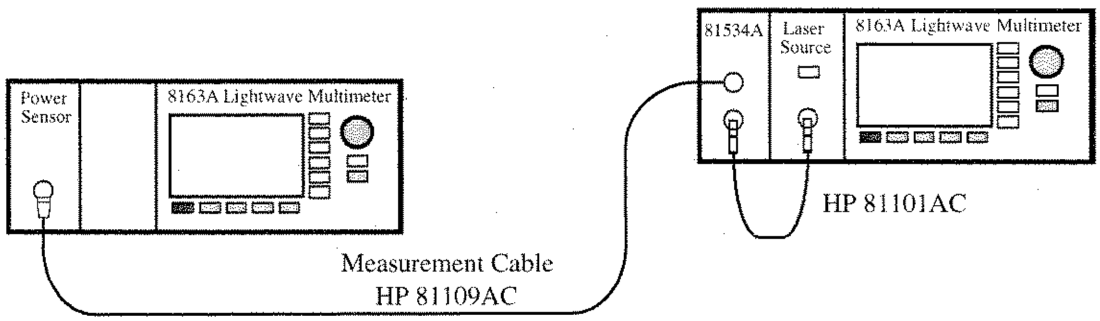



**Figure 92 Measuring the Power Transmitted through the Measurement Cable**

**13** Connect the measurement cable to a Power Sensor as shown in Figure 92.

**14** As you have already, in Step 9 on page 141, set the [*Ref*] parameter to the power transmitted through the reference cable, the Power Sensor channell displays a power value in dB that is equal to the front panel delta.

Enter the power value in dB, [*P*], displayed by the power sensor, as the front panel delta. Move to the Return Loss module channel, press [Menu], move to *<FPDelta>*, enter the power value in dB and press *Enter*.

**15** Press [Close] to exit from the menu.

## Measuring the Return Loss

The value shown in the result field is the return loss.

**16** Attach the DUT. In this example the DUT is a connector pair.

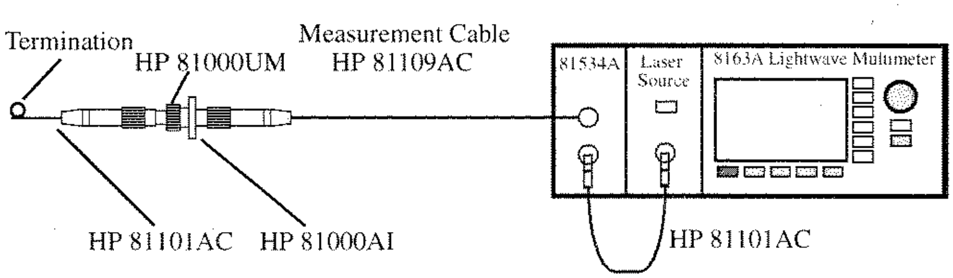



**Figure 93 Measuring the Return Loss of the DUT (in this example: a Connector Pair)**

Terminate your system close to the DUT to make sure that you are only measuring reflections from the DUT.

It is not necessary to make new calibration measurements for each DUT. You can make the calibration measurements for your system, and then measure the return loss of many devices.

## Measuring the Insertion Loss

To measure insertion loss, you must measure the power transmitted through the DUT.

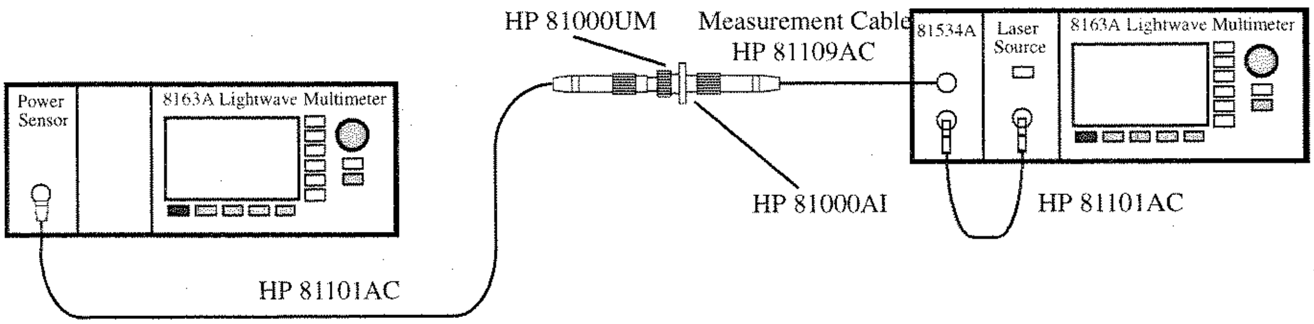



**Figure 94 Measuring the Power Transmitted through the DUT (a Connector Pair)**

**17** Connect the reference cable to a Power Sensor, for example, a Connector Pair, as shown in Figure 94.

**18** As you have already, in Step 9 on page 141, set the [*Ref*] parameter to the power transmitted through the Reference Cable, the displayed power in dB is equal to the insertion loss.

# Viewing the Calibration Values

Whenever the HP 81534A Return Loss Module is in the mainframe, the result field shows return loss. The calibration values used are either the most recently measured, where these are available, or default values.

If you are unsure of one or both of the calibration values you are using or if you have changed your measurement setup, make the appropriate calibration measurements again.

**1** Press [Menu]. Move to the <*Show Calibration*> menu item. The Calibration Parameters Screen appears, as displayed in Figure 95. The Calibration Parameters Screen shows current value for the following quantities:

- <*RL*>, the current Return Loss measurement,
- <*Para*>, the power measured during the termination calibration in dB relative to 1 μW,
- <*Ref*>, the power measured during the reference calibration in dB relative to 1 μW.

- <*Meas*>, the power currently measured by the Return loss Module's internal power sensor in dB relative to 1 μW, and
- <*AvgTime*>, the averaging time.

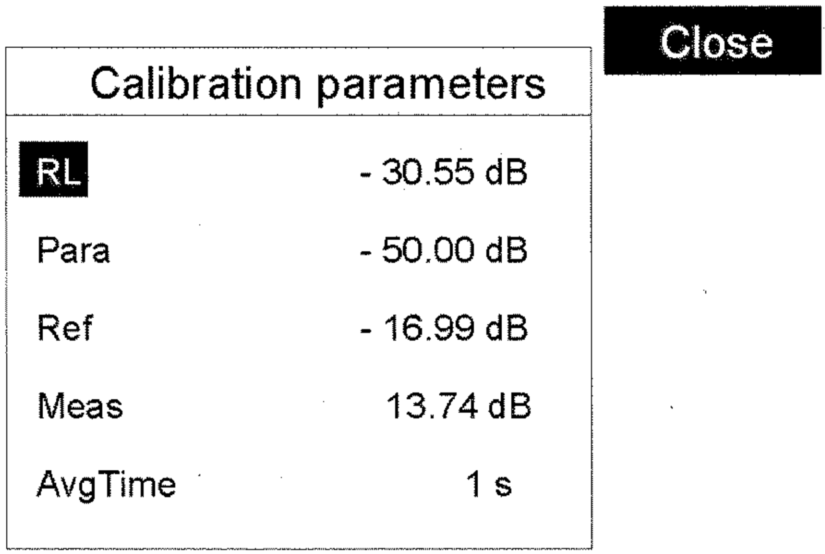



**Figure 95 The Calibration Parameters Screen**

NOTE We recommend that you choose an averaging time of 1 second or longer.

# A Background to Return Loss Measurement with the HP 81534A

## Measuring the Reflected Power from a Component with Known Reflection Factor

First, attach a component with a known reflection factor in place of the DUT, and measure the power reflected. This is component is called the reflection reference.

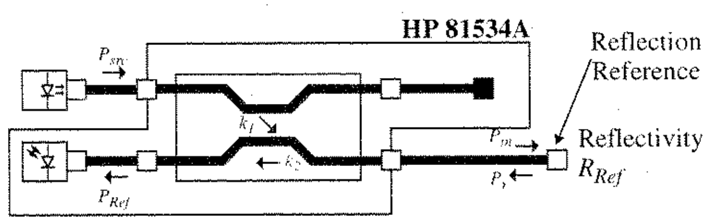



**Figure 96 Measuring the Power from a Component with Known Reflection Factor**

This measured power from the reflection reference is called $P_{Ref}$.

The following two components are recommended for use as a reflection reference:

- a Reflection Reference Cable or
- the HP 81000BR Back Reflector.

NOTE Note you can only measure the Front Panel Delta if you use a Reflection Reference Cable.

The reflection factor for the component is called $R_R$. Normally the return loss for the component ($RL_R$) is specified, but these values are related:

$$RL_R = -10\log R_R = -10\log \frac{P_r}{P_{in}}$$

# Measuring the Power Transmitted Through the Reflection Reference

NOTE Note you can only measure the Front Panel Delta if you use the a Reflection Reference Cable.

Connect your a Reflection Reference Cable to a Power Meter and measure the transmitted power, $E_{ref}$. You can use $E_{ref}$ to calculate the front panel delta, see *"Calculating the Front Panel Delta" on page 149.*

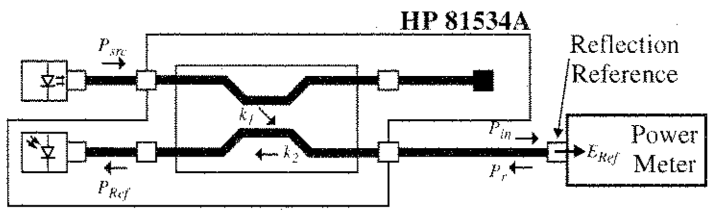



**Figure 97 Measuring the Power Transmitted Through the Reflection Reference**

# Measuring the Power when there are No Reflections

Next, terminate the cable so that there are no reflections from the end. All the power measured by the sensor now, is due to the non-ideal nature of the measurement system. This is our termination parameter.

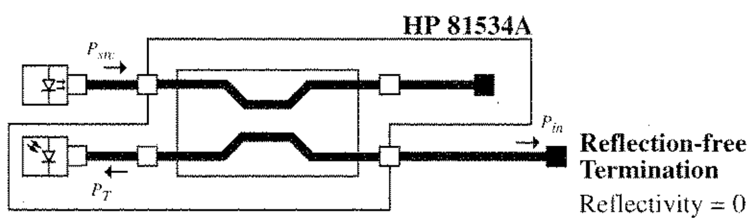



**Figure 98 Measuring the Power with the Connector Terminated**

This measured power for the termination parameter is called $P_T$.

# Measuring the Power Transmitted Through the Measurement Cable

Connect the measurement cable (the cable you will use to connect to the Device Under Test. DUT) directly to a Power Meter and measure the transmitted power, $E_{Meas}$. You can use $E_{Meas}$ to calculate the front panel delta, see *"Calculating the*

*Front Panel Delta" on page 149* and to calculate the insertion loss, see *"Calculating the Insertion Loss of the DUT" on page 151.*

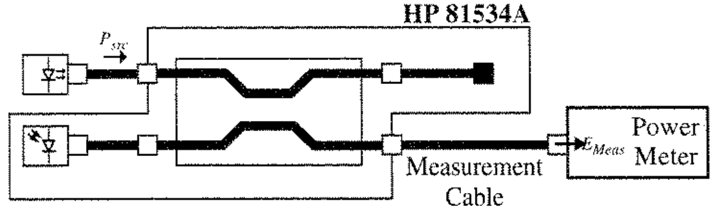



**Figure 99 Measuring the Power Transmitted Through the Measurement Cable**

# Measuring the Reflections from the DUT

Now detach the measurement cable from the Power Meter and attach it to the DUT. The DUT should be terminated.

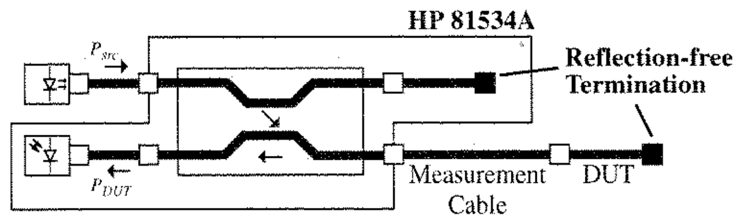



**Figure 100 Measuring the Reflections from the Device Under Test**

The instrument measures the power reflected from the DUT. This power is called $P_{DUT}$.

# Measuring the Power Transmitted Through the DUT

Unterminate the DUT and connect the DUT to a Power Meter so that the power that is transmitted through the DUT can be measured. This power is called $E_{il}$.

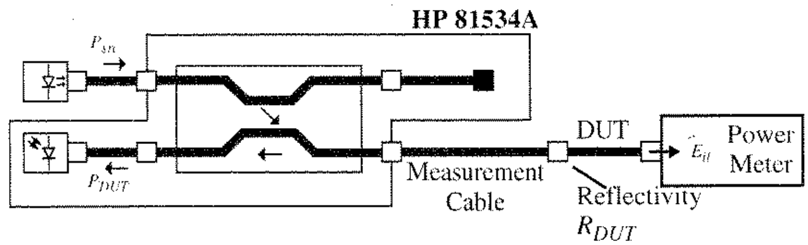



**Figure 101 Measuring the Reflections from the Device Under Test**

You can use $E_{il}$ to calculate the insertion loss, see *"Calculating the Insertion Loss of the DUT" on page 151.*

# Calculating the Return Loss of the DUT

The system may be represented by the general diagram shown in Figure 102.

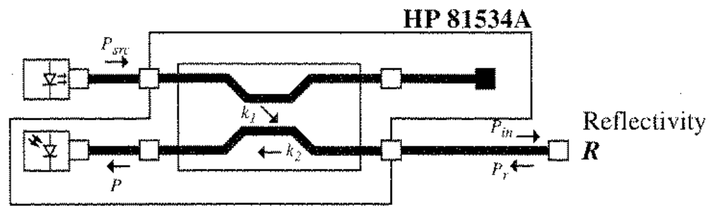



**Figure 102 Generalization of a Return Loss Measurement**

The reflected power, measured by the instrument, ($P$), from the component with the known reflection factor, is given by the sum of:

- the part of the power, reflected by the component, which is transmitted through the coupler, and
- the reflections due to the measurement system.

That is:

$$P = k_1 k_2 R P_{src} + s P_{src} \tag{1}$$

The constants $k_1$ and $k_2$ are multipliers giving the proportion of power transmitted through the coupler from the Input port to the Output port and from the Output port to the sensor port respectively. In other words, when optical power is input at the Output port, $k_2$ times that power is output at the sensor port. It is not necessary to know the value for these constants, they can be eliminated later.

The constant $s$ is a multiplier giving the scattering factor. The scattering factor accounts for the directivity of the second coupler, backscatter in the fiber, and reflections of connectors. The calibration procedure helps you to eliminate the affect of these on return loss measurements.

For *"How to Make Return Loss Measurements with the HP 81534A Return Loss Module" on page 135*, the reflection factor of the component is known. Here we refer to the reflection factor as $R_{Ref}$. This gives the following equation:

$$P_{Ref} = k_1 k_2 R_{Ref} P_{src} + s P_{src} \tag{2}$$

For *"Measuring the Power when there are No Reflections" on page 146*, the value of the reflection factor is zero. This gives the following equation:

$$P_T = s P_{src} \tag{3}$$

For *"Measuring the Reflections from the DUT" on page 147*, the value of the reflection factor of the DUT is called $R_{DUT}$. This gives the following equation:

$$P_{DUT} = k_1 k_2 R_{DUT} P_{src} + s P_{src} \quad (4)$$

If we substitute equation 3 into equations 2 and 4, this gives us the following two equations:

$$P_{Ref} = k_1 k_2 R_{Ref} P_{src} + P_T \quad (5)$$

$$P_{DUT} = k_1 k_2 R_{DUT} P_{src} + P_T \quad (6)$$

If we subtract $P_T$ from equations 5 and 6, this gives us the following equations:

$$P_{Ref} - P_T = k_1 k_2 R_{Ref} P_{src} \quad (7)$$

$$P_{DUT} - P_T = k_1 k_2 R_{DUT} P_{src} \quad (8)$$

If we divide equation 8 by equation 7, this gives us the following equations:

$$R_{DUT} = \left(\frac{P_{DUT} - P_T}{P_{Ref} - P_T}\right) R_{Ref} \quad (9)$$

Thus we can use the equation below to calculate return loss:

$$RL_{DUT} = -10\log R_{DUT} = -10\log\left(\frac{P_{DUT} - P_T}{P_{Ref} - P_T}\right) - 10\log R_{Ref} \quad (10)$$

The return loss of the reference reflection is given by:

$$RL_{Ref} = -10\log R_{Ref} \quad (11)$$

# Calculating the Front Panel Delta

The Front Panel Delta is the change in loss variation that is caused by replacing the reference cable, as used in *"Measuring the Reflection Reference using a Reference Cable" on page 140*, with the measurement cable, as used in *"Measuring the Return Loss" on page 142*. This is caused by differences in reflections from the front panel connector and also differences in the backscatter level of the fibers.

To measure the front panel delta you must measure the power transmitted through the reference cable, *"Measuring the Power Transmitted Through the Reflection Reference" on page 146*, and the power transmitted through the measurement cable, see *"Measuring the Power Transmitted Through the Measurement Cable" on page 146*. The system may be represented by the general diagram shown in Figure 103.

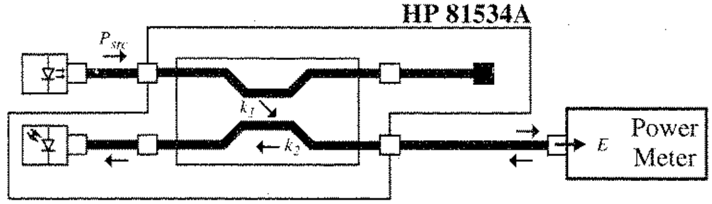



**Figure 103 Generalization of Transmission Measurement**

The transmitted power, ($E$), is directly proportional $P_{src}$.

That is:

$$E = aP_{src} \tag{12}$$

The constant $a$ is a multiplier giving the proportion of power that the light source emits that is measured by the power meter.

The constants $a_{Ref}$ and $a_{Meas}$ apply to the setups described in *"Measuring the Power Transmitted Through the Reflection Reference" on page 146* and in *"Measuring the Power Transmitted Through the Measurement Cable" on page 146* respectively.

This gives the following two equations:

$$E_{Ref} = a_{Ref}P_{src} \tag{13}$$

$$E_{Meas} = a_{Meas}P_{src} \tag{14}$$

If we divide equation 11 by equation 12, this gives the following equation:

$$\frac{E_{Ref}}{E_{Meas}} = \frac{a_{Ref}}{a_{Meas}} \tag{15}$$

The loss variation, $\Delta L$, due to exchanging the reference cable for the measurement cable is given by:

$$\Delta L = -10\log\frac{a_{Ref}}{a_{Meas}} = -10\log\frac{E_{Ref}}{E_{Meas}} \tag{16}$$

When you enter a value for the Front Panel Delta, <*FPDelta*>, the instrument automatically performs the following calculation:

$$RL = RL_{DUT} + 2\Delta L \tag{17}$$

# Calculating the Insertion Loss of the DUT

Insertion Loss is explained in *"What is Insertion Loss ?" on page 134.*

To measure the insertion loss you must measure the power transmitted through the measurement cable, see *"Measuring the Power Transmitted Through the Measurement Cable" on page 146* and the power transmitted through the DUT, see *"Measuring the Power Transmitted Through the DUT" on page 147.*

The equation below gives the insertion loss of the DUT, $IL_{DUT}$:

$$IL_{DUT} = -10\log\frac{E_{il}}{E_{Meas}} \qquad (18)$$

# Applications

This chapter explains how to set up and perform the following applications using the HP 8163A Lightwave Multimeter or HP 8164A Lightwave Measurement System:

- The Logging application logs and displays power measurements. The Logging application performs measurements consecutively without the possibility of any pause between measurements.
- The Stability application logs and displays power measurements. The Stability application differs from the Logging application because:
  - you may use auto-ranging mode, and
  - the period time, the time it takes from the start of one measurement period until another measurement period starts, may be greater than or equal to the averaging time.
- The PACT application coordinates a wavelength sweep using a Tunable Laser source module and power measurement using Power Meters.
- The Pmax Curve application displays the maximum power across the wavelength range of your Tunable Laser source module.

**NOTE** These applications are not available for the HP 8166A Lightwave Multichannel System.

You can access these applications by pressing the *Appl* hardkey.

**NOTE** After you exit from the application, any modules that were available for use by these applications will automatically be preset, all parameters will be set to their default values.

# Working with Application Graphs

If you press the [Graph] softkey, a graph similar to Figure 104 appears. This section explains how to use the graph.

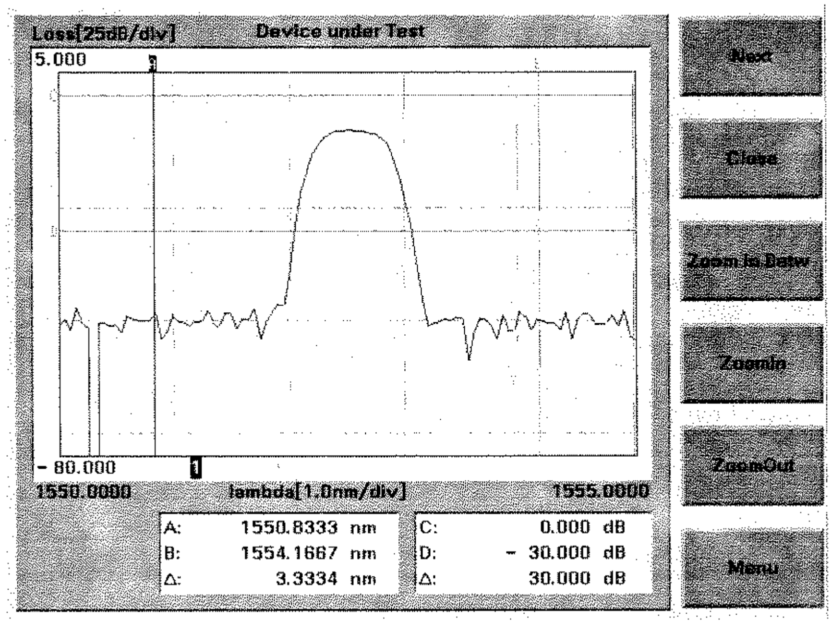



**Figure 104 The Application Graph**

There are four markers A, B, C, and D. You can use these markers to choose the area of the graph that you wish to zoom into.

For the Logging and Stability applications, the time values of A and B are displayed at the bottom of the screen in units of seconds. The symbol Δ that is listed directly beneath these values, displays the difference between A and B in seconds.

For the PACT application, the wavelength values of A and B are displayed at the bottom of the screen in units of nanometers (nm). The symbol Δ that is listed directly beneath these values, displays the difference between A and B in nanometers (nm).

The power values of C and D are displayed at the bottom of the screen in the chosen power units. The symbol Δ that is listed directly beneath these values, displays the difference between C and D in the chosen power units.

NOTE As a default, the C and D markers are out of range when you first open a graph. See *"How to Set Markers" on page 156*, for more information on setting moving markers.

# How to Set Markers

To position a marker:

1 Move to the marker by pressing [Next], the *Enter* hardkey, or the Modify Knob repeatedly until the marker is selected.

2 You can change the position of a marker in one of the following ways:

- Press [Menu], move to <*Set Active Marker*>, and press *Enter*. The current setting for the selected marker appears. Edit this value to your required value and press *Enter*.
- For A or B, use the left and right cursor keys to position the marker.
- For C or D, use the up and down cursor keys to position the marker.
- Use the Modify Knob to position the marker, this is quicker than using the cursor keys.

NOTE The Modify Knob is only available for the HP 8164A Lightwave Measurement System.

# How to Zoom In

To zoom in one level around the active marker:

1 Press the [Next] softkey until you move to your chosen marker.

2 Position the marker using the cursor key.

3 Press the [ZoomIn] softkey to zoom in one level around the active marker. In this way, you can zoom in around the active marker and the zoom function is separate for the x and y axes.

You can also zoom in between markers:

1 Set each marker as described above in *"How to Set Markers" on page 156.*

2 Press the [Zoom In Betw] softkey to zoom in between the markers.

# How to Zoom Out

To zoom out one level around the active marker:

1 Press the [Next] softkey until you move to your chosen marker.

2 Position the marker using the cursor key.

3 Press the [ZoomOut] softkey to zoom out one level from the active marker. In this way, you can zoom out from the active marker and the zoom function is separate for the x and y axes.

To zoom out to the fullest extent:

1 Press the [Menu] softkey. The menu appears.

2 Move to *<Zoom to Overview>*.

# To Switch the Grid On/Off

As a default, the graph is displayed with gridlines.

To switch this grid off:

1 Press the [Menu] softkey. The menu appears.

2 Move to *<Grid Off>*.

If the grid has been switched off, to switch the grid on:

1 Press the [Menu] softkey. The menu appears.

2 Move to *<Grid On>*.

# How to Use Legends

Legends are used to identify Power Meter channels on the graph in the following ways:

- Legend numbers that are displayed on the graph.
- Legend texts can be accessed by pressing the [Menu] softkey and moving to *<Legend>*.

## How to Identify Curves

Legend numbers can be related to the curves they represent in the following ways:

- For the HP 8163A Lightwave Multimeter the legend number is displayed at the same height as the first sample of the power measurement channel on the right-hand side of the screen.
- For the HP 8164A Lightwave Measureemnt System, the legend numbers are disrectly beneath the graph. Each number is the same colour as the curve it represents.

## How to Change the Legend Label

To change the legend label:

NOTE You cannot edit a legend label while a measurement is running.

1 Press the [Menu] softkey and move to *<Legend>*. A list of the Power Meter channels appears that is similar to Figure 105. where all the Power Meters are listed numerically with regard to legend number. All legend texts, if you have

not previously edited the legend text, are of the "PM *x.y*", where *x* represents the slot number and *y* represents the channel number.

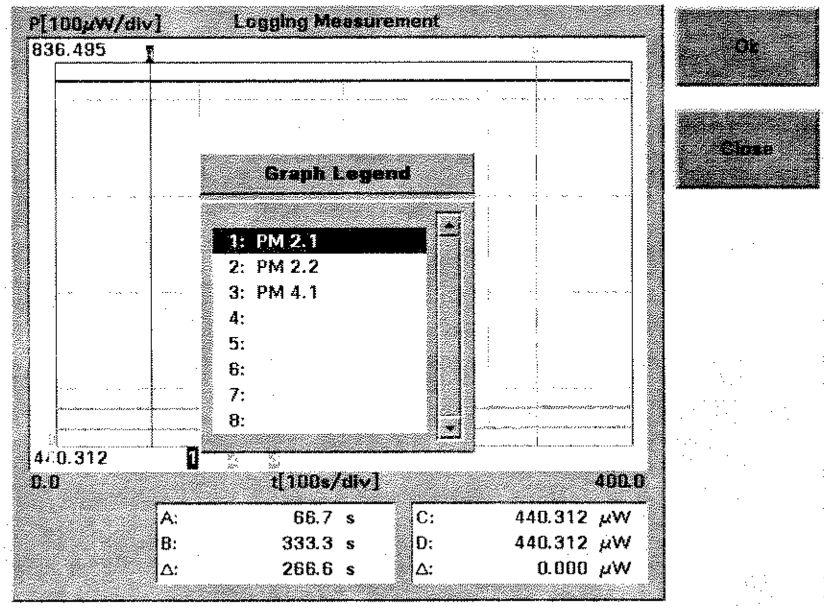



**Figure 105 The Graph Legend Screen**

2 Move to the legend number you wish to edit using the cursor keys and press *Enter*. The on-screen keyboard appears.

3 Use the on-screen keyboard to edit the legend label and press *Enter*.

The on-screen keyboard uses the following softkeys:

- Move to the required character using the cursor keys and press the [Select] softkey to select to add the selected character to the end of the legend label.
- Press the [Delete] softkey to delete the last character of the legend label.
- Press the [CapsLock] softkey to toggle between upper and lower case characters.
- Press the [Cancel] to reject the edited legend label and return to the menu.
- Press the [OK] to accept the edited legend label and return to the menu.

# How to Select the Samples Display

The samples display determines how the curves of the graph are represented. To choose the samples display:

1 Press the [Menu] softkey and move to <*Samples Display*>. A box displaying the following options appears:

- <*Line*> - the curve will be displayed using a line that connects between each sample of the curve.

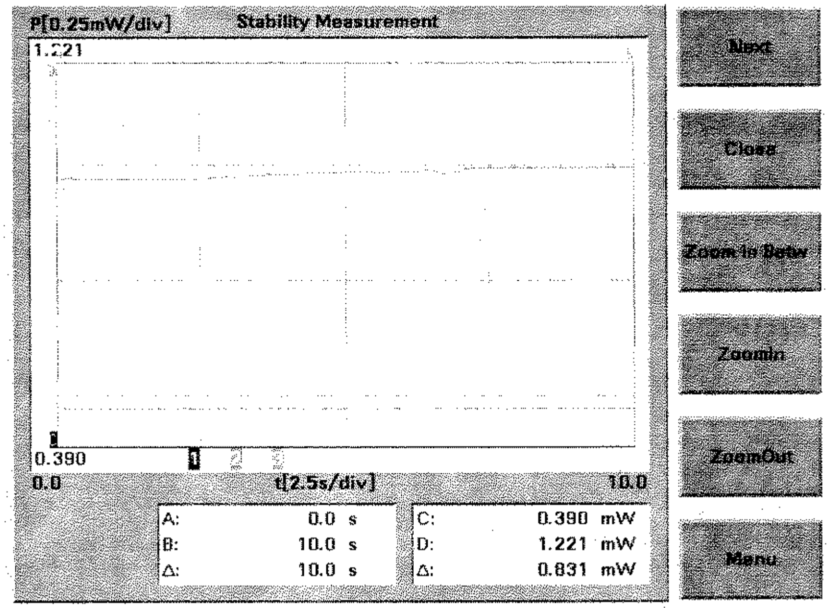



**Figure 106 Samples Display - <*Line*>**

- <*Samples*> - the curve will be displayed using dots to represent each sample of the curve. Depending on the zoom level you choose, if these dots are very close to each other, the curve will resemble a line.

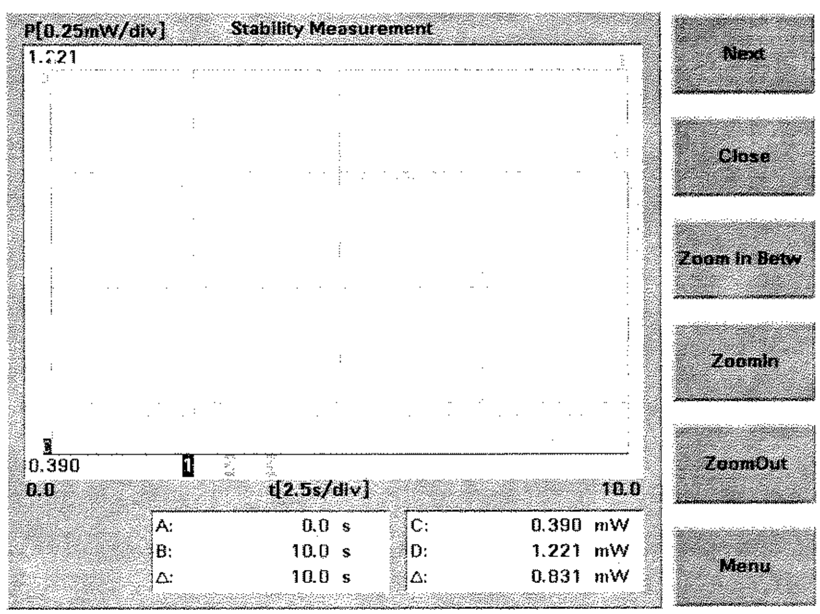



**Figure 107 Samples Display - <*Samples*>**

- <*Samples & Line*> - the curve will be displayed using both symbols for each sample of the curve and a line connecting each sample.

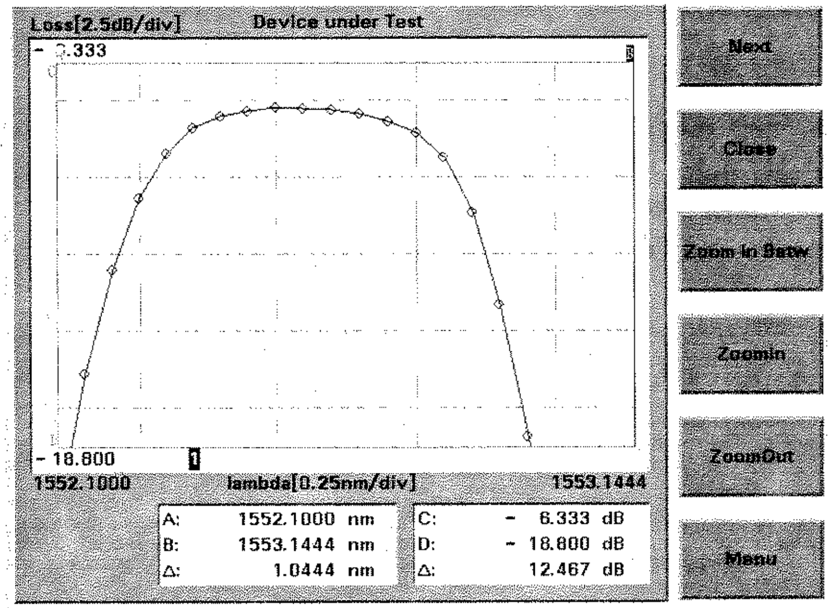



**Figure 108** **Samples Display - <*Samples & Line*>**

**2** Move to your selected option and press *Enter*.

**3** Press the [Close] softkey to return to the graph.

# How to Read Curve Values

You can lock markers A or B to a curve in order to move between individual samples. In this way, you can read the time/wavelength and power values that relate to each sample and the difference between these values for markers A and B.

## How to Lock Markers to the Curve

You can lock markers A and B to curves by performing the following instructions:

1 Press the [Menu] softkey and move to <*Lock to Curve*>. A menu displaying the options displayed in *"The Lock to Curve Menu" on page 161* appears.

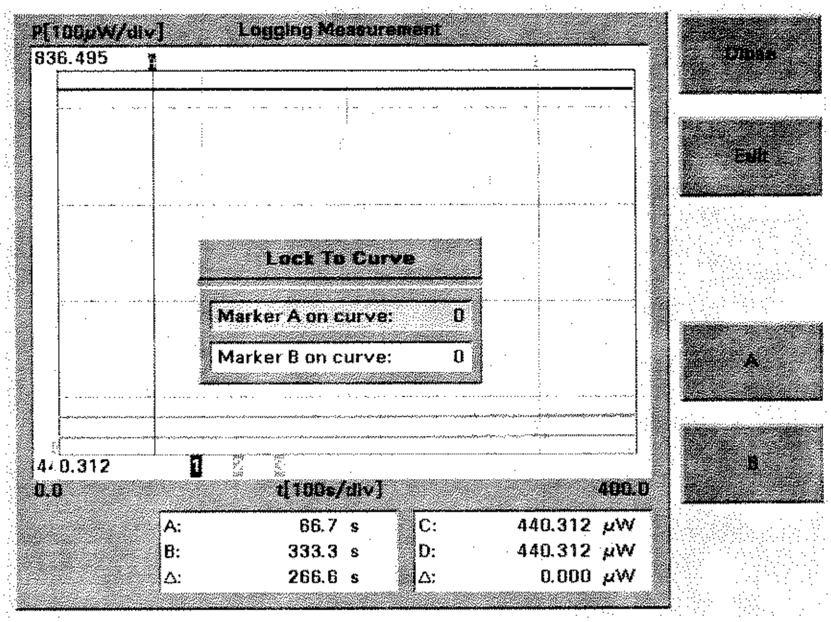



**Figure 109 The Lock to Curve Menu**

2 Press the [A] softkey to lock marker A to a curve. The number opposite `Marker A on curve:` is highlighted.

3 Use the cursor key to move to the legend number of the curve to which you want to lock marker A.

4 Press *Enter*. Marker B will be locked to the same curve as marker A, if it was assigned to curve 0 immediately before, that is, it was unassigned immediately before.

5 If you want to assign marker B to another curve, press the [B] softkey, use the cursor key to move to the legend number of the curve to which you want to lock marker B, and press *Enter*.

6 Press Close to return to the graph.

## How to Unlock Markers from the Curve

You can unlock markers A and B from the curve by performing the following instructions:

1 Press the [Menu] softkey.

2 Move to <*Unlock From Curve*> and press *Enter* to return to the graph.

## How to Lock/Unlock Markers to Samples

You can choose to lock the markers to samples, that is, the results that are returned are actual measurement results.

Figure 110 shows a graph where markers A and B are locked to samples. If you press the cursor key, the marker will move to another sample.

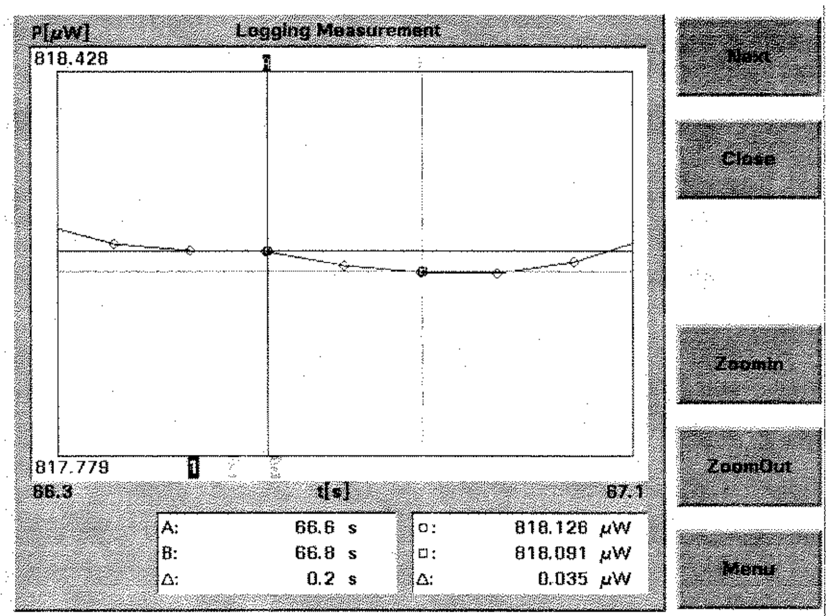



**Figure 110 Lock to Samples On**

Figure 111 shows a graph where markers A and B are not locked to samples. If you press the cursor key, the marker will move along the curve.

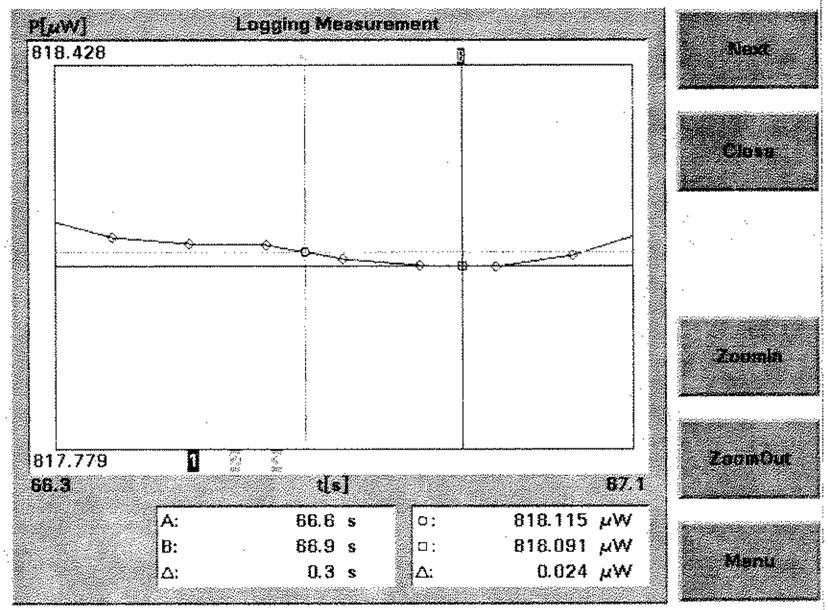



**Figure 111 Lock to Samples Off**

NOTE You can only lock/unlock markers to samples if you have already locked markers to the curve, see *"How to Lock Markers to the Curve" on page 161*.

To lock/unlock markers to samples:

1 Press the [Menu] softkey.
2 Move to one of the following menu items:
   - <Lock to Samples On>, to lock markers to samples or
   - <Lock to Samples Off>, to lock markers to the curve.

NOTE Only one of these menu items will be available for selection.

3 Press *Enter* to return to the graph.

# The Logging Application

The Logging data acquisition application logs a series of power measurements for a number of Power Meter channels, plots the results as a graph, and generates a statistical analysis of the results.

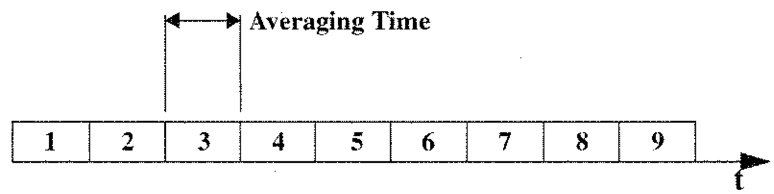



**Figure 112 Example Logging Application**

The most important parameters for the logging application are:

- [*Samples*], this is the number of samples that will be performed during the logging application, and
- [*AvgTime*], the averaging time is the length of time over which a signal is averaged. Longer averaging times increase the accuracy and improve the noise rejection. Longer averaging times also decrease sensitivity.

The total time for a logging application is the number of samples multiplied by the averaging time.

The Logging application differs from the *"The Stability Application" on page 173* because all power measurements are performed consecutively without the possibility of any pause between measurements, as shown in Figure 112.

All results can be:

- displayed on the screen,
- printed out to hardcopy, or
- saved to disk drive of your HP 8164A Lightwave Measurement System.

# How to Set Up a Logging Function

To set up a logging function:

1 Press the *Appl* hardkey. The Applications menu, as shown in Figure 113, appears.

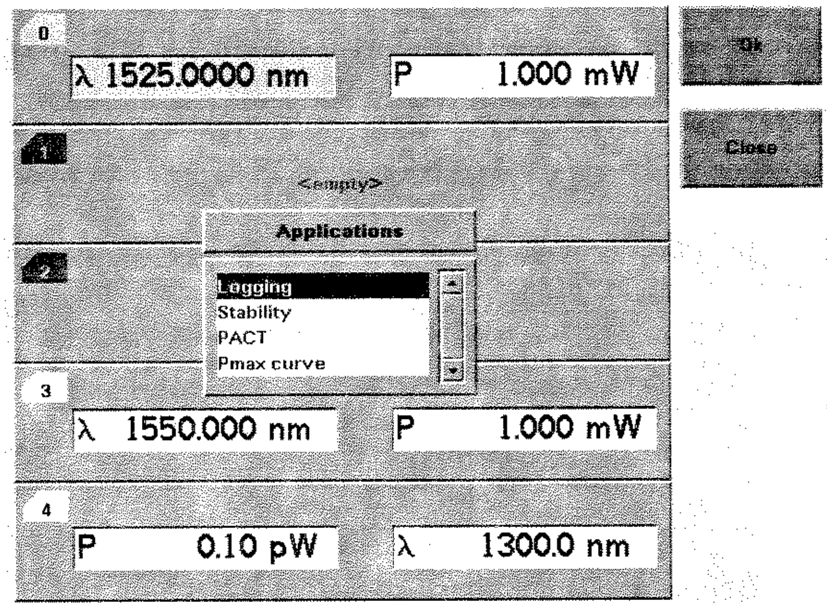



**Figure 113 The Application Menu**

2 Move to *<Logging>* and press *Enter*. The HP 8164A Logging Setup Screen, as shown in Figure 114, or the HP 8163A Logging Modules Setup Screen, as shown in Figure 115, appears depending on the mainframe instrument you are using.

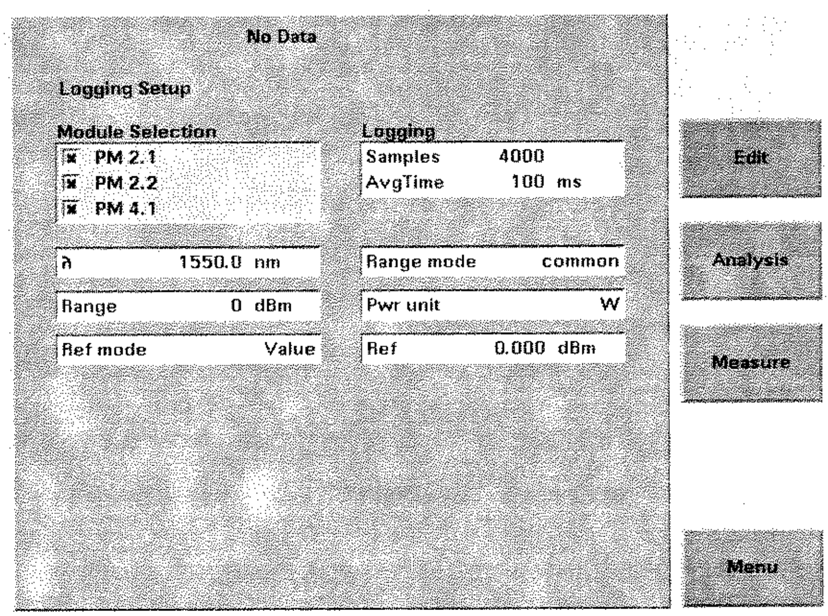



**Figure 114 The HP 8164A Logging Setup Screen**

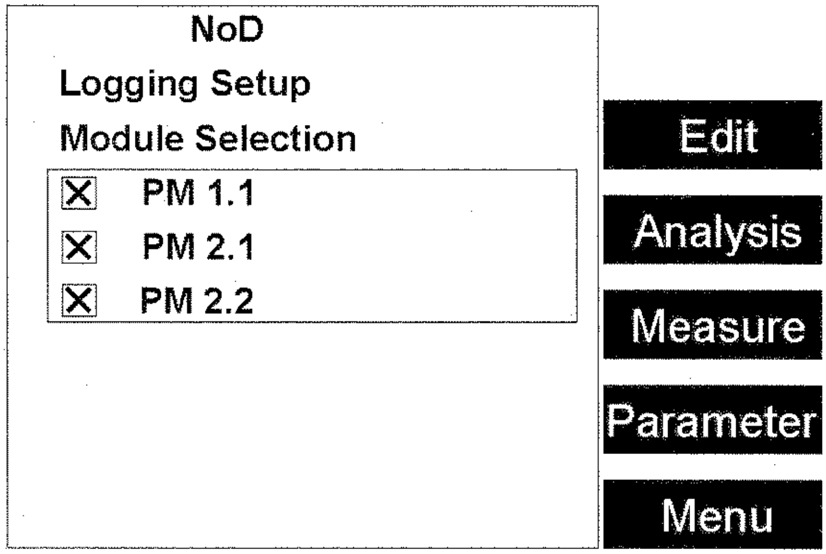



**Figure 115 The HP 8163A Logging Modules Setup Screen**

## Selecting/Deselecting Power Meters

3 Move to the Module Selection box. As a default, all Power Meters are selected, this means that all Power Meters will log power measurements. Press [Edit].

4 To deselect a Power Meter channel, move to the Power Meter as denoted by slot and channel numbers, see *"Slot and Channel Numbers" on page 36*, press [Unset].

5 To select a Power Meter channel, press [Edit], move to the Power Meter as denoted by slot and channel numbers, see *"Slot and Channel Numbers" on page 36*, press [Set].

6 Perform steps until you have selected the required Power Meters for your application and press *Enter*.

NOTE If no Power Meter channel is selected, you cannot exit by pressing *Enter*.

## Setting Power Meter Parameters

NOTE If you are using the HP 8164A Lightwave Multimeter, you may set all Power meter parameters from the Logging Setup Screen, see Figure 114.

NOTE If you are using the HP 8163A Lightwave Multimeter, press [Parameter] to access the Logging Parameter Setup Screen, as shown in Figure 116. To rewturn to the Logging Modules Setup Screen, press [Modules].

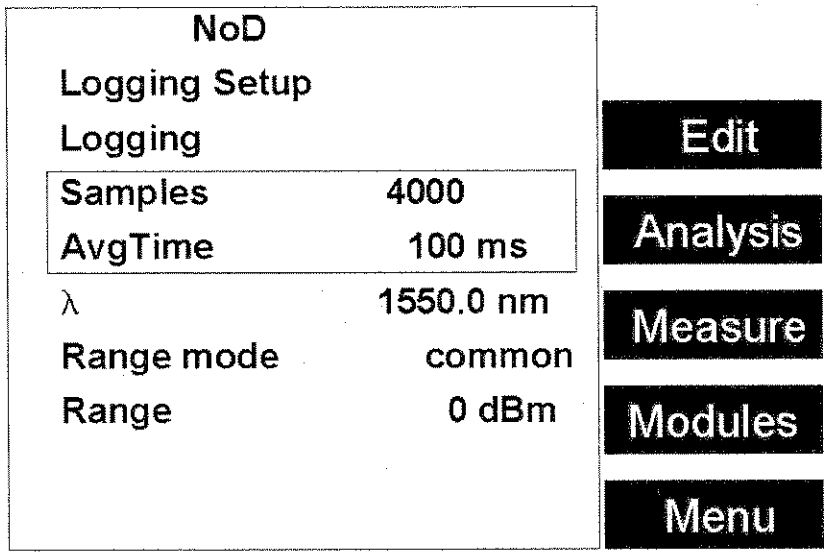



**Figure 116 The HP 8163A Logging Parameter Setup Screen**

7 Press [Menu] to access the Logging application menu screen.

8 Move to <*Pwr unit*>, press *Enter*, move to <*dBm*>, <*W*>, or <*dB*>, and press *Enter*. See *"What are the Power Units ?" on page 72* for an explanation of power units.

9 Move to <λ>, press *Enter*, enter the wavelength value of your optical source, and press *Enter*.

NOTE Make sure that you install Power Meters that have similar wavelength ranges. The wavelength range of the application is the overlapping wavelength range of all installed Power Meters

10 Move to <*Range Mode*>, press *Enter*, move to one of the following range modes:

- <*common*>, you set the same <*Range*> for each Power Meter,
- <*individual*>, you must choose an individual <*Range*> for each Power Meter, and

press *Enter*.

NOTE Auto-ranging mode is not available from the <*Range Mode*> menu. If you wish to use the auto-ranging mode, see *"The Stability Application" on page 173*.

11 Move to <*Range*> and press *Enter*.

**12** If you have chosen *<common>* as the *<Range Mode>*, move to a range setting and press *Enter*.

If you have chosen *<individual>* as the *<Range Mode>*, a screen displaying all the selected Power Meter channels and their corresponding range settings is displayed. For each selected Power Meter channel, press *Enter*, move to a range setting, and press *Enter*.

NOTE If you have chosen *<individual>* as the *<Range Mode>* and want to access the screen displaying all the selected Power Meter channels and their corresponding range settings from the Logging Setup screen, move to [*Range*], press the [Edit] softkey.

**13** Move to *<Ref Mode>*, press *Enter*, move to one of the following referencing modes:

- *<Value>*, you set a reference value using *<Ref>*, see step 14,
- *<First Sample>*, the first sample for each channel of the logging function is selected as the reference value for all subsequent measurements for that channel,
- *<Channel 1>*, the value that Channel 1 measures is updated as the reference value for each set of power measurements (thus, each data value for channel 1 will be 0 dB), and

press *Enter*.

NOTE These settings only have an effect when you choose *<dB>* as the *<Pwr unit>*. See step 8 or step 22.

**14** If you have chosen *<Value>* as the *<Ref Mode>*, move to *<Ref>*, press the [Edit] softkey, enter a value for the reference, and press *Enter*.

## Setting Logging Parameter

**15** Move to [*Samples*], press *Enter*, enter an integer value between 1 and 4000, and press *Enter*.

**16** Move to *<AvgTime>*, press *Enter*, move to an averaging time period, and press *Enter*.

# Running a Logging Application

**17** You can run the logging application by pressing [Measure]. The Logging Measurement screen, as shown in Figure 117, appears. A progress bar at the bottom of the screen shows the proportion of the logging application that has been completed.

**NOTE** If the averaging time [*AvgTime*] is less than 100 ms for a HP 8163A Series Power Meter, the progress bar and the graph are not updated until the measurement completes.

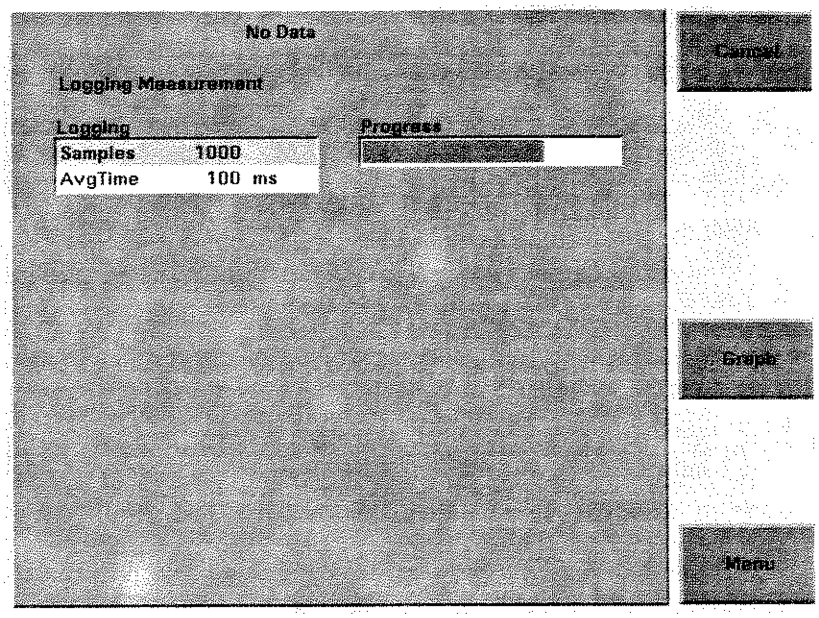



**Figure 117 The Logging Measurement Screen - Measurement Running**

**18** There are two softkeys available from the Logging Measurement screen.

- Press [Graph] to view a graph of the Measurement results as the results are measured. Press [Close] to return to the Logging Measurement screen. See *"Working with Application Graphs" on page 155* for information on zooming in and out.
- Press [Cancel] to return to the Logging Setup screen without completing the logging application.

**19** When the logging application completes, you hear a beep, an hourglass appears momentarily. If you are viewing the Logging Measurement Screen the available softkeys change as shown in Figure 118.

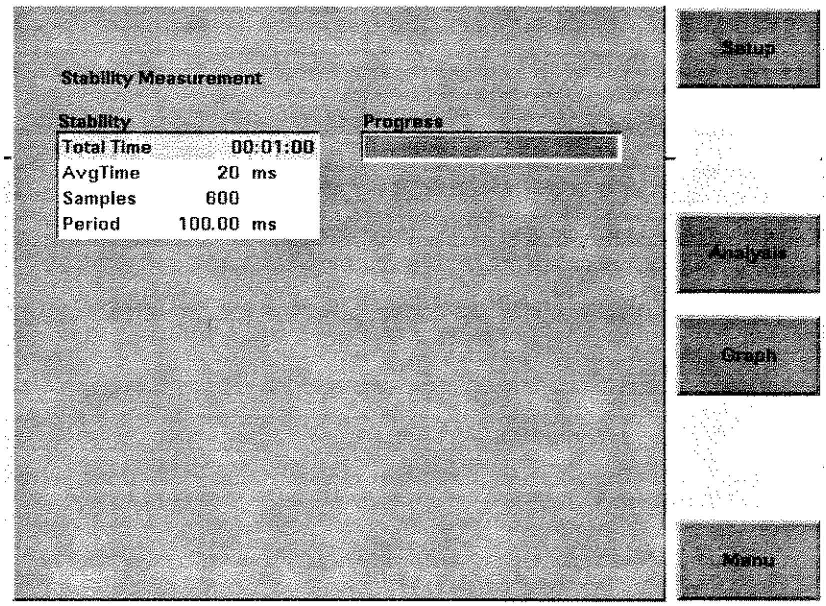



**Figure 118 The Logging Measurement Screen - Measurement Completed**

# Analysing a Logging Application

You can access the Logging Analysis screen after the logging application completes, by completing the following instructions:

**20** You cannot access the Logging Analysis screen from the graph. If you are viewing the graph, press [Close].

21 Press [Analysis]. The Logging Analysis screen appears as shown in Figure 119 for the HP 8164A and Figure 120 for the HP 8163A.

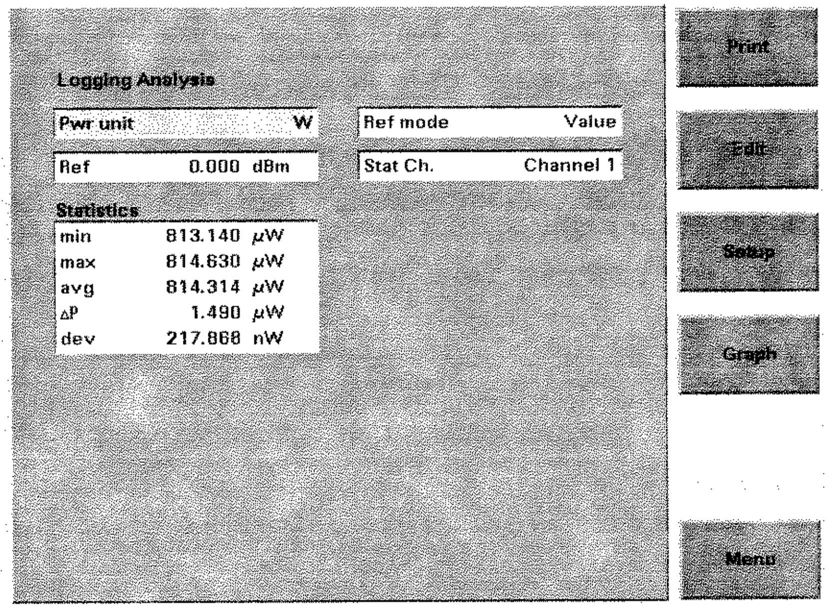



Figure 119 The HP 8164A Logging Analysis Screen

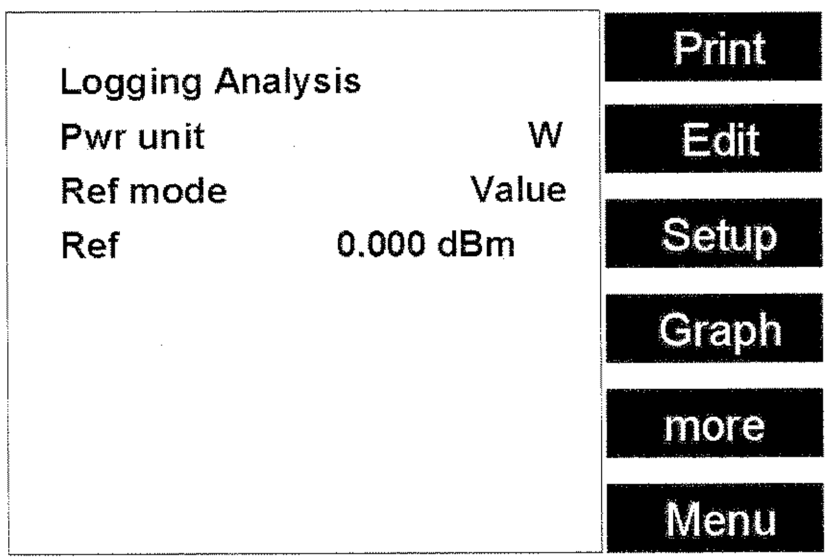



Figure 120 The HP 8163A Logging Analysis Screen - First Screen

## Setting Analysis Parameters

22 To edit the power units used for the analysis, move to [*W*], press *Enter*, move to <*dBm*>, <*W*>, or <*dB*>, and press *Enter*. See *"What are the Power Units ?" on page 72* for an explanation of power units.

23 To edit the reference mode used for the analysis, move to <*Ref Mode*>, press *Enter*, move to one of the following referencing modes:

- <*Value*>, you set a reference value using <*Ref*>, see step 24,
- <*First Sample*>, the first sample of the logging function is selected as the reference value,
- <*Channel 1*>, the value that Channel 1 measures is updated as the reference value for each set of power measurements (thus, each data value for channel 1 will be 0 dB), and

press *Enter*.

NOTE These settings have an effect when you choose <*dB*> as the <*Pwr unit*>. See step 8 or step 22.

**24** If you have chosen <*Value*> as the <*Ref Mode*>, move to <*Ref*>, press *Enter*, enter a value for the reference, and press *Enter*.

## Viewing the Statistics for a Power Meter Channel

**25** If you are using the HP 8164A, move to [*Stat Ch.*], press *Enter*, move to a Power Meter channel, and press *Enter*.

If you are using the HP 8163A, press [More], the screen in Figure 121 appears, move to [*Stat Ch.*], press *Enter*, move to a Power Meter channel, and press *Enter*.

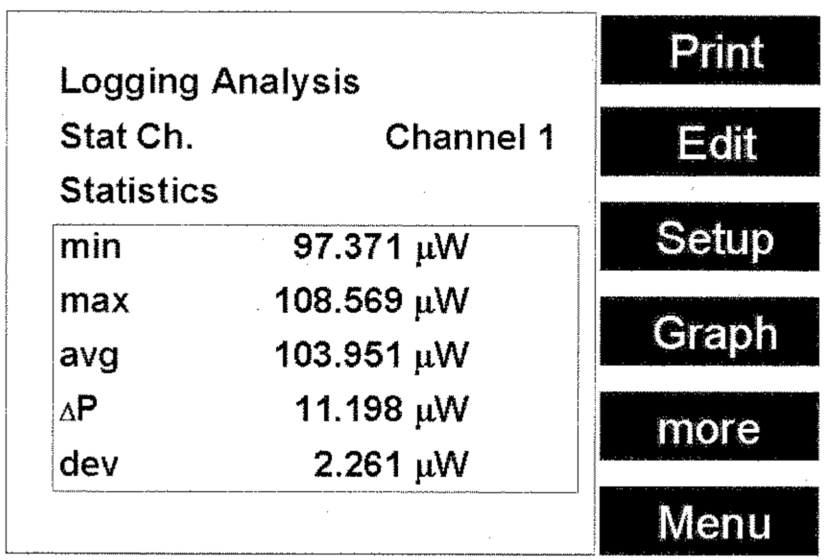



**Figure 121 The HP 8163A Logging Analysis Screen - Second Screen**

**26** The following statistics are displayed for the chosen Power Meter channel:

- [*min*], the minimum power measurement measured,
- [*max*], the maximum power measurement measured,
- [*avg*], the average of all power measurements measured,
- [*ΔP*], the difference between [*max*] and [*min*],

– [*dev*], the standard deviation of all power measurements measured.

## On-Screen Messages

The messages listed in the table below may appear at the top[ of the screen during the Logging application.

| HP8163A Message | HP8164A Message | Description |
|---|---|---|
| OvR | Overrange | One of the Power Meter channels has reported an over-range. The over-ranged value is clipped, statistical data is invalid. |
| NoH | No Head | There is an Optical Head Interface module inserted in the mainframe that does not have an Optical Head connected to it. No measurement is possible using this channel until you either:<br>• reconnect an Optical Head or<br>• deselect this Optical Head channel as a power measurement channel. |
| NoD | No Data | No data has been measured or measurement is not yet finished. You cannot access the Analysis Screen yet. Printout and file operations are not yet possible. |

**Table 4 Logging Application On-Screen Messages**

# The Stability Application

The Stability data acquisition application logs a series of power measurements for a number of Power Meter channels, plots the results as a graph, and generates a statistical analysis of the results.

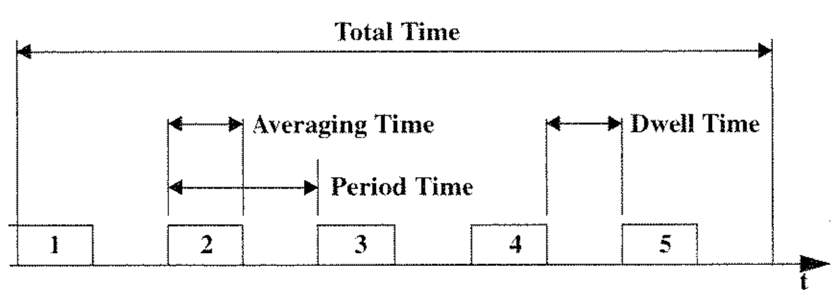



**Figure 122 Example Stability Application**

The Stability application differs from the *"The Logging Application" on page 164* because you set the averaging time, the total time, and the maximum number of measurements and all power measurements and the instrument calculates a period time, a new measurement is started after the completion of every period time. Period time may be greater than or equal to the averaging time you set and is always greater than or equal to 100 ms.

This leaves the following two possibilities:

- The averaging time is less than the period time, there is a dwell time between the commencement of each power measurement, as shown in Figure 122. This can happen because:
  - the maximum number of power measurements multiplied by the averaging time is less than the total time or
  - the averaging time is less than 100 ms.
- The averaging time is equal to the period time, all power measuremant are performed without any dwell time.

**NOTE** The total time concludes after the last dwell time period, not after the last averaging time period.

The Stability application enables you to make periodic power measurements over a relatively long time period (23 hours, 59 minutes and, 59 seconds).

The Stability application differs from *"The Logging Application" on page 164* because you may use auto-ranging mode. see step 9 on page 177 for more information.

All results can be:

- displayed on the screen,
- printed out to hardcopy, or
- saved to disk drive of your HP 8164A Lightwave Measurement System.

## How to Set Up a Stability Function

To set up a stability function:

1 Press the *Appl* hardkey. The Applications menu, as shown in Figure 113, appears.

Move to <*Stability*> and press *Enter*. The Stability Setup Screen, as shown in Figure 123, appears.

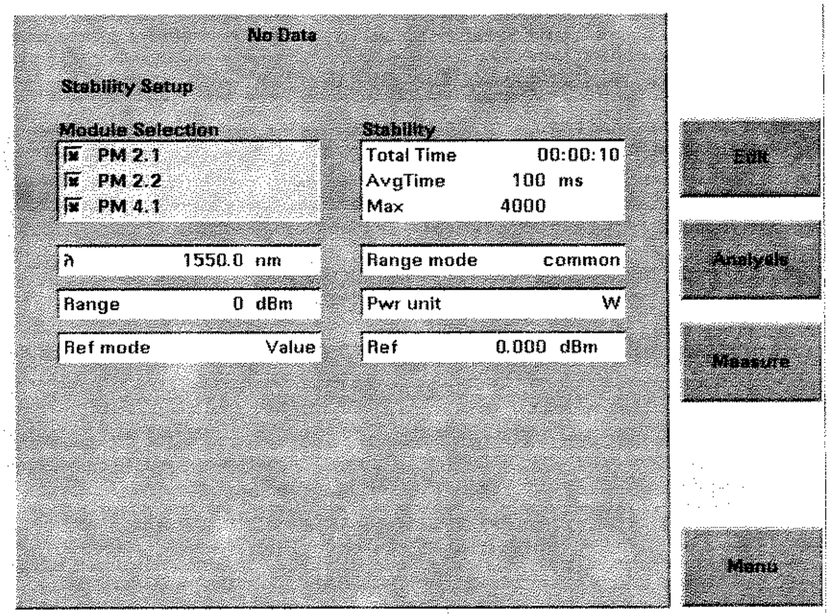



**Figure 123 The HP 8164A Stability Setup Screen**

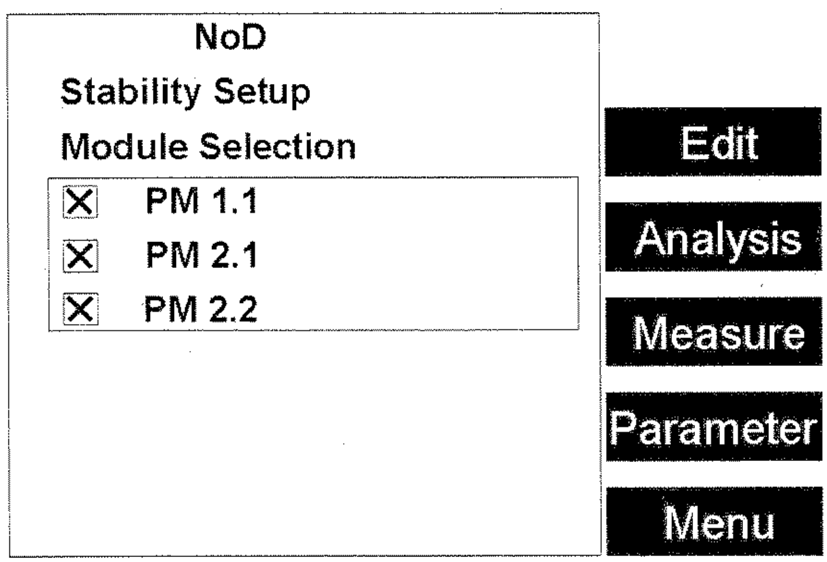



**Figure 124 The HP 8163A Stability Module Setup Screen**

## Selecting/Deselecting Power Meters

2 Move to the Module Selection box. As a default, all Power Meters are selected, this means that all Power Meters will log power measurements. Press [Edit].

3 To deselect a Power Meter channel, move to the Power Meter as denoted by slot and channel numbers, see *"Slot and Channel Numbers" on page 36*, press [Unset].

4 To select a Power Meter channel, press [Edit], move to the Power Meter as denoted by slot and channel numbers, see *"Slot and Channel Numbers" on page 36*, press [Set].

5 Perform steps until you have selected the required Power Meters for your application and press *Enter*.

NOTE If no Power Meter channel is selected, you cannot exit by pressing *Enter*.

## Setting Power Meter Parameters

NOTE If you are using the HP 8163A Lightwave Multimeter, press [Modules] to access the Stability Setup Screen, as shown in Figure 125. Not all parameters are available from the Stability Setup Screen.

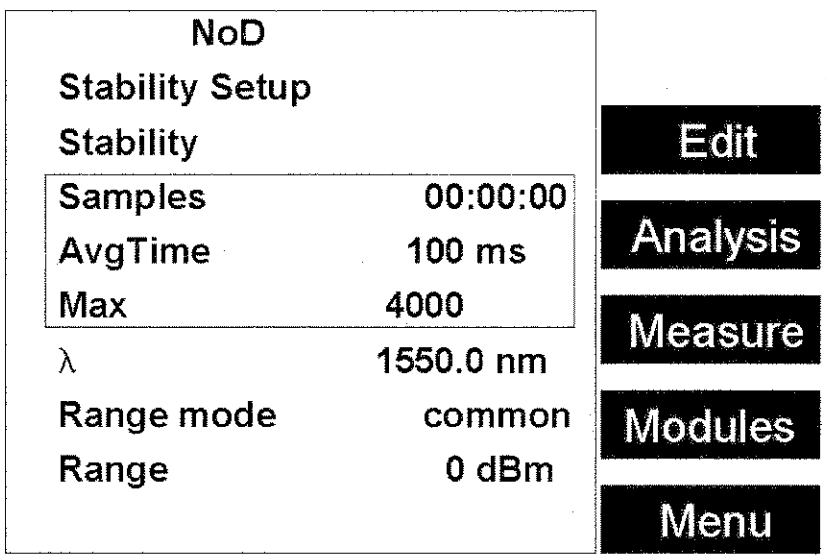



**Figure 125 The HP 8163A Stability Parameter Setup Screen**

6 Press [Menu] to access the Stability application menu screen.

7 Move to <*Pwr unit*>, press *Enter*, move to <*dBm*>, <*W*>, or <*dB*>, and press *Enter*. See *"What are the Power Units ?" on page 72* for an explanation of power units.

8 Move to <λ>, press *Enter*, enter the wavelength value of your optical source, and press *Enter*.

**NOTE** Make sure that you install Power Meters that have similar wavelength ranges. The wavelength range of the application is the overlapping wavelength range of all installed Power Meters

**9** Move to <*Range Mode*>, press *Enter*, move to one of the following range modes:

- <*common*>, you set the same <*Range*> for each Power Meter,
- <*individual*>, you must choose an individual <*Range*> for each Power Meter,
- <*Auto*>, the auto-ranging mode, ensures that the result has a displayed value between 9% and 100% of full scale, and

press *Enter*.

**NOTE** If you choose <*Auto*> and the power range changes, the time base of the stability application will be disrupted.

**10** Move to <*Range*> and press *Enter*.

**11** If you have chosen <*common*> as the <*Range Mode*>, move to a range setting and press *Enter*.

If you have chosen <*individual*> as the <*Range Mode*>, a screen displaying all the selected Power Meter channels and their corresponding range settings is displayed. For each selected Power Meter channel, press *Enter*, move to a range setting, and press *Enter*.

**12** Move to <*Ref Mode*>, press *Enter*, move to one of the following referencing modes:

- <*Value*>, you set a reference value using <*Ref*>, see step 13,
- <*First Sample*>, the first sample of the stability function is selected as the reference value,
- <*Channel 1*>, the value that Channel 1 measures is updated as the reference value for each set of power measurements (thus, each data value for channel 1 will be 0 dB), and

press *Enter*.

**NOTE** These settings have an effect when you choose <*dB*> as the <*Pwr unit*>. See step 7 or step 22.

**13** If you have chosen <*Value*> as the <*Ref Mode*>, move to <*Ref*>, press *Enter*, enter a value for the reference, and press *Enter*.

## Setting Stability Parameter

**14** Move to [*Total Time*], press *Enter*. [*Total Time*] is a value of the form xx:yy:zz, where xx is a value in hours (maximum 23 hours), yy is a value in

minutes (maximum 59 minutes), and zz is a value in seconds (maximum 59 seconds).

Enter a two-digit time value in hours, press the right cursor key, enter a two-digit time value in minutes, press the right cursor key, enter a two-digit time value in seconds, and press *Enter*.

15 Move to [*AvgTime*], press *Enter*, move to an averaging time period, and press *Enter*.

16 Move to [*Max*], press *Enter*, enter an integer value between 1 and 4000, and press *Enter*.

# Running a Stability Application

17 You can run the stability application by pressing [Measure]. The Stability Measurement screen, as shown in Figure 126, appears. A progress bar at the bottom of the screen shows the proportion of the stability application that has been completed.

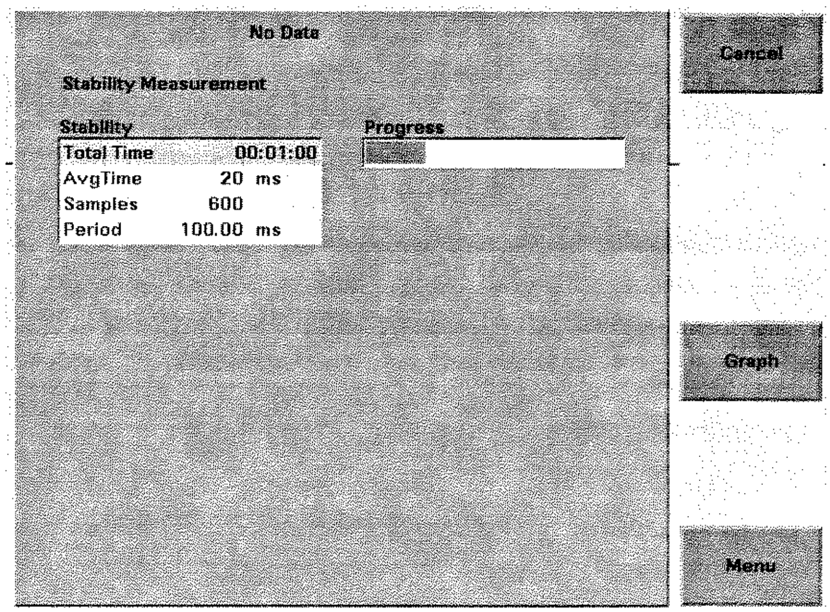



**Figure 126 The Stability Measurement Screen - Measurement Running**

18 There are two softkeys available from the Stability Measurement screen.

- Press [Graph] to view a graph of the Measurement results as the results are measured. Press [Close] to return to the Stability Measurement screen. See *"Working with Application Graphs" on page 155* for information on zooming in and out.
- Press [Cancel] to return to the Stability Setup screen without completing the stability application.

19 When the stability application completes, you hear a beep, an hourglass appears momentarily. If you are viewing the Stability Measurement Screen, the available softkeys change as shown in Figure 126.

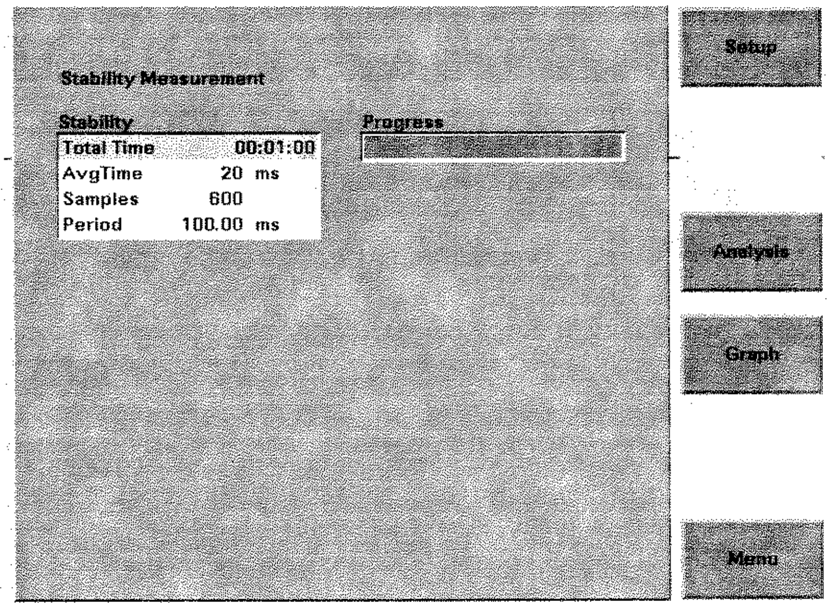



**Figure 127 The Stability Measurement Screen - Measurement Completed**

# Analysing a Stability Application

You can access the Stability Analysis screen after the stability application completes, by completing the following instructions:

20 You cannot access the Stability Analysis screen from the graph. If you are viewing the graph, press [Close].

21 Press [Analysis]. The Stability Analysis screen appears as shown in Figure 128 for the HP 8164A and Figure 129 for the HP 8163A.

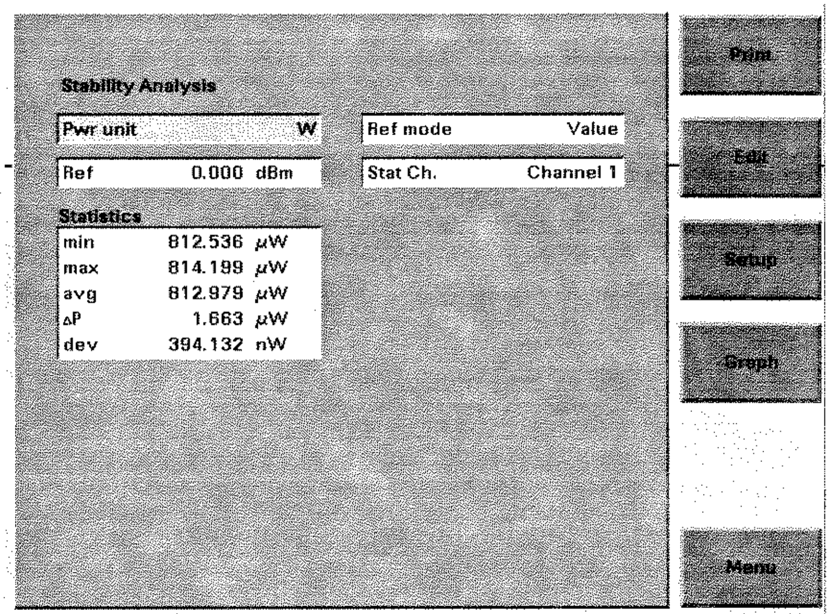



Figure 128 The HP 8164A Stability Analysis Screen

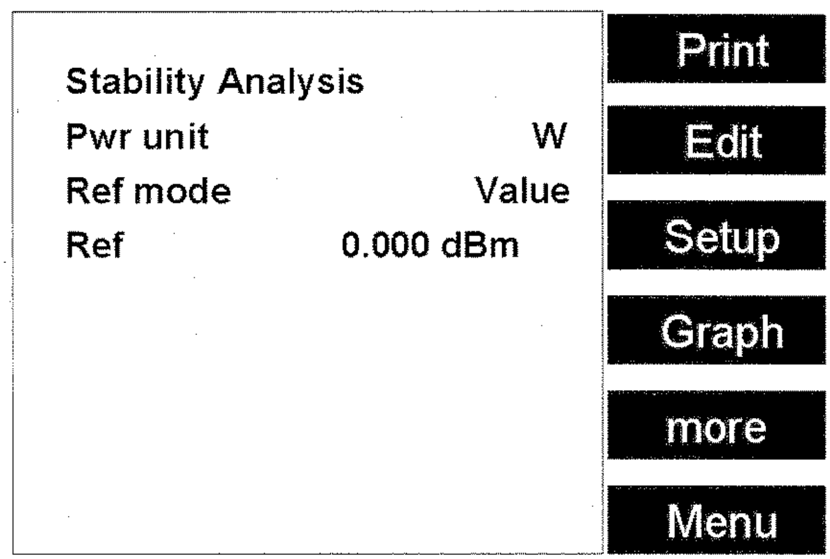



Figure 129 The HP 8163A Stability Analysis Screen - First Screen

## Setting Analysis Parameters

22 To edit the power units used for the analysis, move to [*W*], press *Enter*, move to <*dBm*>, <*W*>, or <*dB*>, and press *Enter*. See *"What are the Power Units ?" on page 72* for an explanation of power units.

23 To edit the reference mode used for the analysis, move to <*Ref Mode*>, press *Enter*, move to one of the following referencing modes:

- <*Value*>, you set a reference value using <*Ref*>, see step 24,
- <*First Sample*>, the first sample of the stability function is selected as the reference value,
- <*Channel 1*>, the value that Channel 1 measures is updated as the reference value for each set of power measurements (thus, each data value for channel 1 will be 0 dB), and

press *Enter.*

NOTE These settings have an effect when you choose <*dB*> as the <*Pwr unit*>. See step 7 or step 22.

**24** If you have chosen <*Value*> as the <*Ref Mode*>, move to <*Ref*>, press *Enter*, enter a value for the reference, and press *Enter.*

## Viewing the Statistics for a Power Meter Channel

**25** If you are using the HP 8164A, move to [*Stat Ch.*], press *Enter*, move to a Power Meter channel, and press *Enter.*

If you are using the HP 8163A, press [More], the screen in Figure 130 appears, move to [*Stat Ch.*], press *Enter*, move to a Power Meter channel, and press *Enter.*

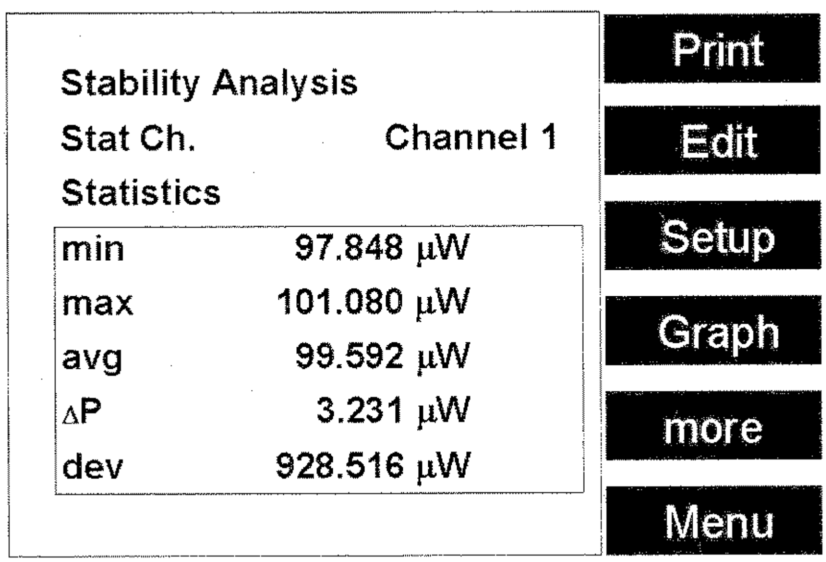



**Figure 130** **The HP 8163A Stability Analysis Screen - Second Screen**

**26** The following statistics are displayed for the chosen Power Meter channel:

- [*min*], the minimum power measurement measured,
- [*max*], the maximum power measurement measured,
- [*avg*], the average of all power measurements measured.
- [Δ*P*], the difference between [*max*] and [*min*],

– [*dev*], the standard deviation of all power measurements measured.

## On-Screen Messages

The messages listed in the table below may appear at the top of the screen during the Stability application.

| HP8163A Message | HP8164A Message | Description |
|---|---|---|
| `OvR` | `Overrange` | One of the Power Meter channels has reported an over-range. The over-ranged value is clipped, statistical data is invalid. |
| `NoH` | `No Head` | There is an Optical Head Interface module inserted in the mainframe that does not have an Optical Head connected to it. No measurement is possible using this channel until you either:<br>• reconnect an Optical Head or<br>• deselect this Optical Head channel as a power measurement channel. |
| `NoD` | `No Data` | No data has been measured or measurement is not yet finished. You cannot access the Analysis Screen yet. Printout and file operations are not yet possible. |

**Table 5 Stability Application On-Screen Messages**

# The PACT Application

## What is the PACT ?

PACT (Passive Component Test Software) makes it possible to use your HP 8163A Lightwave Multimeter or HP 8164A Lightwave Measurement System to control a system for testing pigtailed or connectorized passive devices (filters, couplers, and isolators) over wavelength. You must first install a Tunable Laser module and Power Meters in your HP 8163A Lightwave Multimeter or HP 8164A Lightwave Measurement System.

Depending on the configuration of the system you use, you can measure insertion loss (single channel power measurement) over wavelength.

All results can be:

- displayed on the screen,
- printed out to hardcopy, or
- saved to disk drive of your HP 8164A Lightwave Measurement System.

# How to Set Up PACT

To set up PACT:

1 Insert a Tunable Laser module and at least one Power Meter module into your HP 8163A Lightwave Multimeter or HP 8164A Lightwave Measurement System.

2 Turn your instrument on.

3 Press the *Appl* hardkey. The Applications menu, as shown in Figure 113, appears.

4 Move to *<PACT>* and press *Enter*. The PACT Setup Screen, as shown in Figure 131, appears.

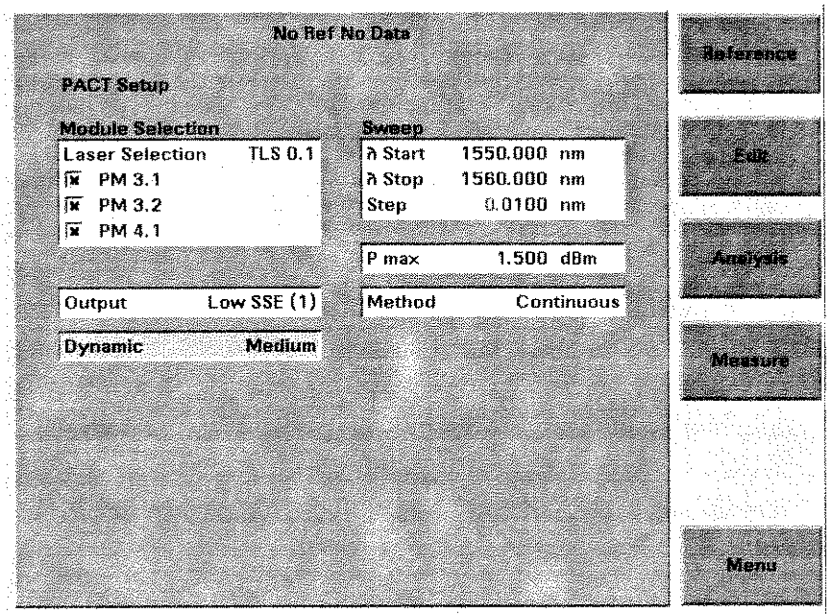



**Figure 131 The PACT Setup Screen**

## Selecting a Tunable Laser Module

5 Move to the Module Selection box. As a default, the Tunable Laser module with the lowest slot number is selected. Move to [*Laser Selection*]. Press [Edit].

6 To select a Tunable Laser module, press [Edit], use the cursor key to move to your preferred Tunable Laser module as denoted by slot and channel numbers, see *"Slot and Channel Numbers" on page 36*, and press *Enter*.

7 Perform steps until you have selected the required Tunable Laser modules for your application and press *Enter*.

NOTE If no Tunable Laser module is selected, you cannot exit by pressing *Enter*.

## Selecting/Deselecting Power Meters

8 Move to the Module Selection box. As a default, all Power Meters are selected, this means that all Power Meters will log power measurements. Press [Edit].

9 To deselect a Power Meter channel, move to the Power Meter as denoted by slot and channel numbers, see *"Slot and Channel Numbers" on page 36*, press [Unset].

10 To select a Power Meter channel, press [Edit], move to the Power Meter as denoted by slot and channel numbers, see *"Slot and Channel Numbers" on page 36*, press [Set].

11 Perform steps until you have selected the required Power Meters for your application and press *Enter*.

NOTE If no Power Meter channel is selected, you cannot exit by pressing *Enter*.

## Setting Sweep Parameters

12 Move to [λ *Start*], press *Enter*, enter the start wavelength of the sweep, and press *Enter*.

13 Move to [λ *Stop*], press *Enter*, enter the stop wavelength of the sweep, and press *Enter*.

14 Move to [*Step*], press *Enter*, enter the step size for the sweep, and press *Enter*.

NOTE The step size defines:

- the size of the change in the wavelength for each step of a stepped sweep and
- the wavelength interval between power measurements, the first power measurement is taken at [λ *Start*] and the last must be taken at [λ *Stop*].

15 Move to [*P max*], press *Enter*, enter the maximum power in dBm for the sweep, and press *Enter*. The instrument chooses a constant power level for the measurement using the following constraints:

– the power will be less than or equal to the [*P max*] value you set and

– the power will be less than or equal to the maximum power possible for the chosen Tunable Laser module across the chosen wavelength range.

16 Move to [*Method*], press *Enter*, and move to one of the following sweep modes:

– <*Stepped*>, which dwells at wavelengths that are separated by a certain step size, or

– <*Continuous*>, which sweeps continually at the speed you set.

Press *Enter*.

NOTE <*Continuous*> sweep mode is not available for all Tunable Laser modules.

*[Dynamic]* The *[Dynamic]* parameter, which is only relevant for *<Continuous>* sweep mode, allows you to achieve a higher dynamic range than is possible using one wavelength sweep. Depending on the menu item you choose, the Tunable Laser will be swept once, twice, or three times and the chosen Power Meters will be set to different power ranges for each wavelength sweep. The sweeps are combined using a "stitching" process to generate the final results.

This feature is useful when you wish to measure the transmission characteristics of a component that transmits or absorbs specific wavelengths selectively, for example, a Fiber Bragg Grating.

**17** Move to *[Dynamic]*, press *Enter*, and move to one of the following:

- *<Low>*, the wavelength is swept once, achieving a lower dynamic range but sweeping more quickly,
- *<Medium>*, the wavelength is swept twice, achieving a medium dynamic range and medium speed, and
- *<High>*, the wavelength is swept once, achieving a higher dynamic range but sweeping less quickly.

Press *Enter.*

**18** If your Tunable Laser module has two optical outputs perform the step below.

Move to *[Optical Output]* and press *Enter.* Use the Modify Knob to move to one of the following:

- *<High Power (2)>*, a high power optical output, for example, for use in tesing Erbium Doped Fiber Amplifiers (EDFAs), you see a screen similar to Figure 61,
- *<Low SSE (1)>*, a lower power optical output with low Source Spontaneous Emission (SSE), for example, for use in passive component test, you see a screen similar to Figure 62,
- *<Both (master:2)>*, where both optical outputs can be enabled but only the output of the high power optical output can be regulated, and
- *<Both (master:1)>*, where both optical outputs can be enabled but only the output of the low SSE optical output can be regulated.

Press *Enter.*

# How to Measure the Reference

**19** Press [Reference].

NOTE If *[Step]* does not divide exactly into the difference between *[λ Stop]* and *[λ Start]*, the parameters are automatically corrected to meet the constraints of PACT.

The PACT Reference Screen, as shown in Figure 132, appears. The number of samples that each Power Meter will record and the output laser power are

displayed If *<Continuous>* was selected as the sweep [*Method*], the sweep speed, [*V Sweep*], is displayed.

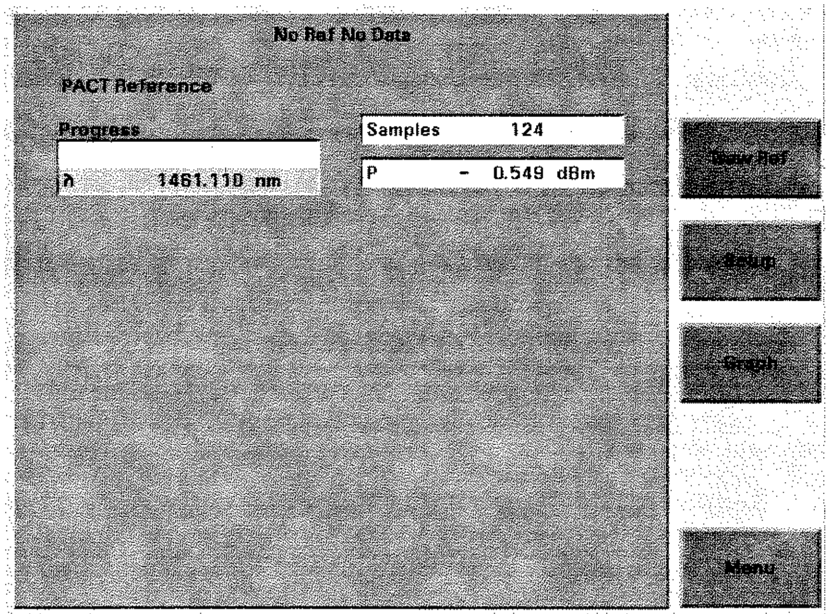



**Figure 132 PACT Reference Screen**

NOTE The application chooses the power, [*P*], see step 15 for more information.

**20** Press [New Ref]. A box similar to the box in Figure 133 appears prompting you to connect a fiber to the first Power Meter channel.

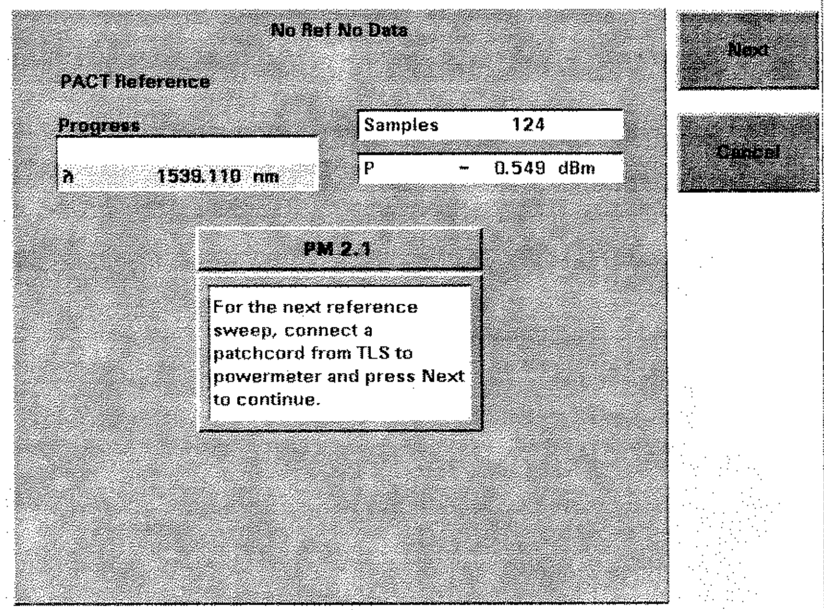



**Figure 133 Connection Prompt Screen**

**21** Connect the Tunable Laser module to the Power Meter channel through all the system components, but excluding the Device Under Test. Press [Next] to start the reference measurement.

The PACT Reference Measurement screen, as shown in Figure 134, appears. A progress bar at the bottom of the screen shows the proportion of the stability application that has been completed. The wavelength, λ, shows you the current wavelength of the Tunable Laser module.

**22** There are two softkeys available from the PACT Reference Measurement screen.

- Press [Graph] to view a graph of the Measurement results as the results are measured. Press [Close] to return to the PACT Reference Measurement screen. See *"Working with Application Graphs" on page 155* for information on zooming in and out.
- Press [Cancel] to return to the PACT Reference screen without completing the reference measurement, all reference values that were measured will be deleted.

23 When the PACT Reference Measurement completes, you hear a beep, an hourglass appears momentarily.

If there is another Power Meter channel to reference, you will be prompted to perform this reference measurement from the user interface by a prompt box similar to the box in Figure 133. Restart this procedure at step 21.

If you are viewing the PACT Reference Measurement Finished box, reference sweeps have been performed for all selected Power Meters.

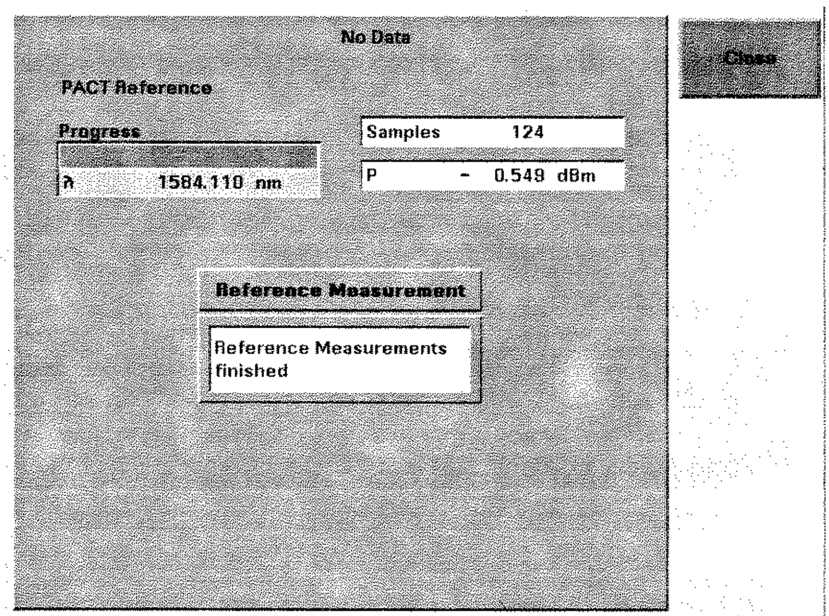



**Figure 134 PACT Reference Measurement Finished Box**

# How to Perform a Loss Measurement

24 To return to the Setup screen, pressing [Menu], move to <*Setup*>, and press *Enter*.

NOTE If you change any measurement parameters, the reference measurement becomes invalid.

25 Connect the Tunable Laser module to the Power Meter channel through all the system components, including the Device Under Test. Press [Measure].

NOTE If [*Step*] does not divide exactly into the difference between [λ *Stop*] and [λ *Start*], the parameters are automatically corrected to meet the constraints of PACT.

If the step size is very large in comparison to the sweep range, a box requesting you to correct the [λ *Stop*], [λ *Start*], and [*Step*] may appear.

The PACT Measurement Screen, as shown in Figure 135, appears. The number of samples that each Power Meter will record and the output laser power are displayed. If <*Continuous*> was selected as the sweep [*Method*], the sweep speed, [*V Sweep*], is displayed.

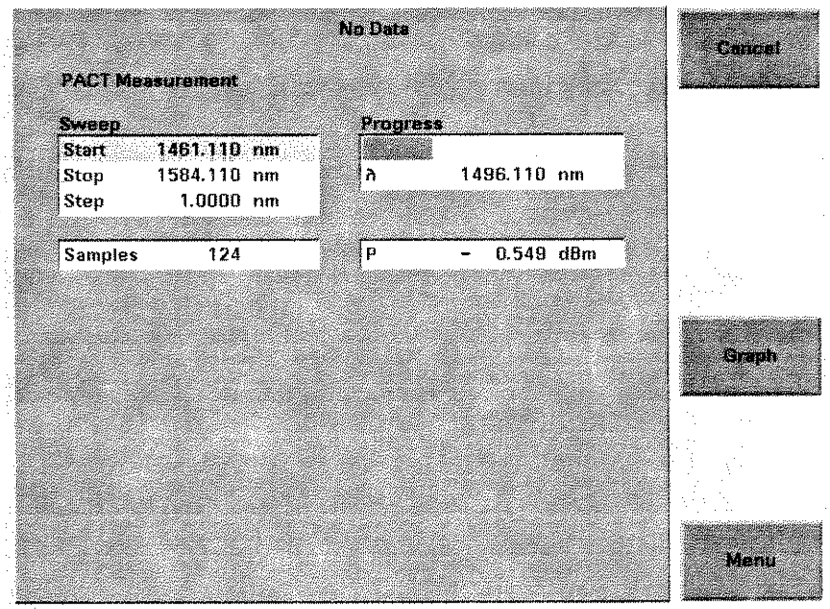



**Figure 135 PACT Measurement Screen**

NOTE The application chooses the power, [*P*], see step 15 for more information.

**26** There are two softkeys available from the PACT Measurement screen.

- Press [Graph] to view a graph of the Measurement results as the results are measured. Press [Close] to return to the PACT Reference Measurement screen. See *"Working with Application Graphs" on page 155* for information on zooming in and out.
- Press [Cancel] to return to the PACT Reference screen without completing the stability application.

NOTE If you choose <*High*> or <*Medium*> as the [*Dynamic*] parameter and <*Continuous*> sweep mode, the graph will update at the end of each sweep. Figure 136 shows a graph with low dynamic range that is the result of a single

sweep. Figure 137 shows a graph with high dynamic range that is the result of a three sweeps that were combined using a "stitching" process.

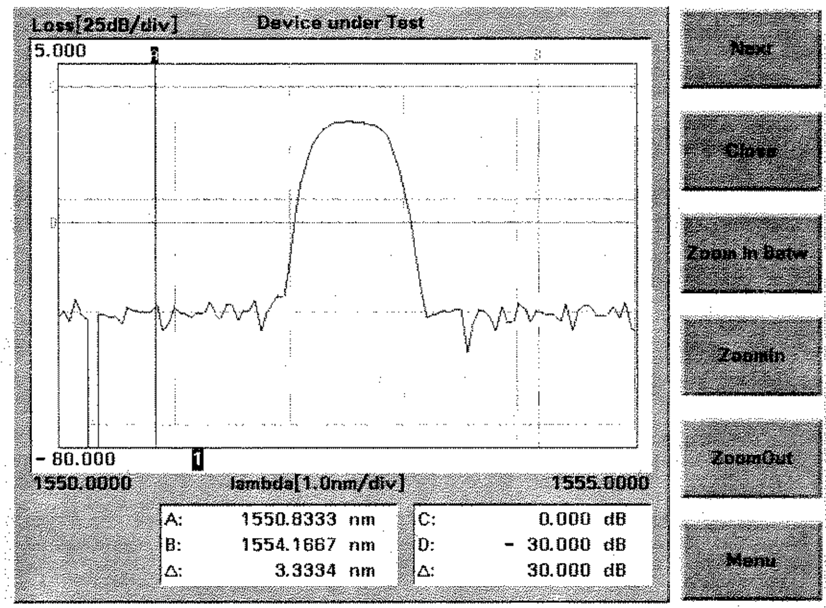



**Figure 136 Low Dynamic Range**

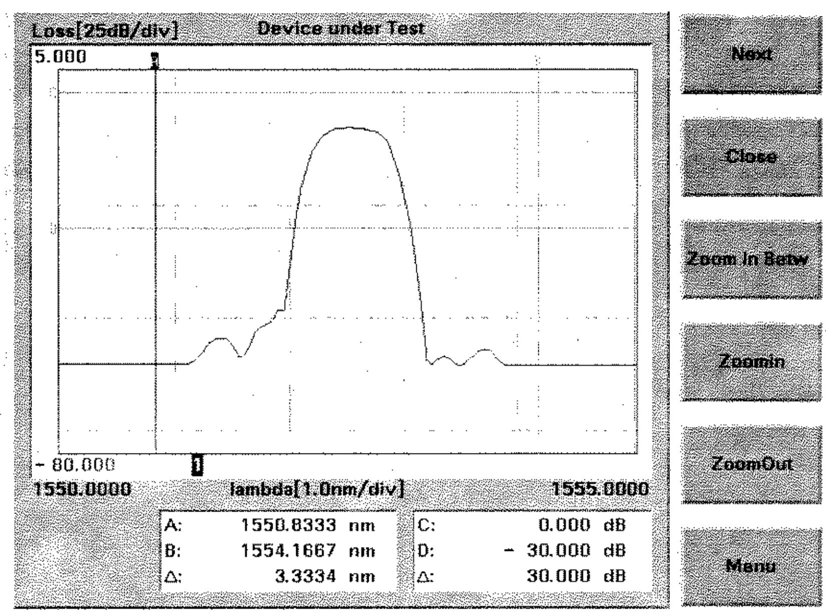



**Figure 137 High Dynamic Range**

27 When the PACT Measurement application completes, you hear a beep, an hourglass appears momentarily. If you are viewing the PACT Measurement Screen, the available softkeys change as shown in Figure 138.

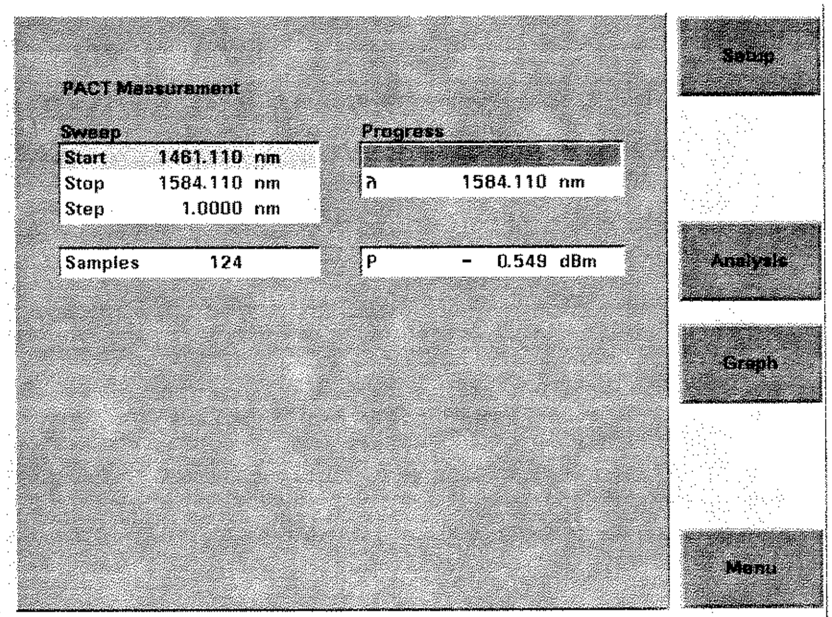



**Figure 138 The PACT Measurement Screen - Measurement Completed**

# Analysing a PACT Measurement

You can access the PACT Analysis screen after the PACT Measurement completes, by completing the following instructions:

28 You cannot access the PACT Analysis screen from the graph. If you are viewing the graph, press [Close].

29 Press [Setup]. The Logging Analysis screen appears as shown in Figure 119.

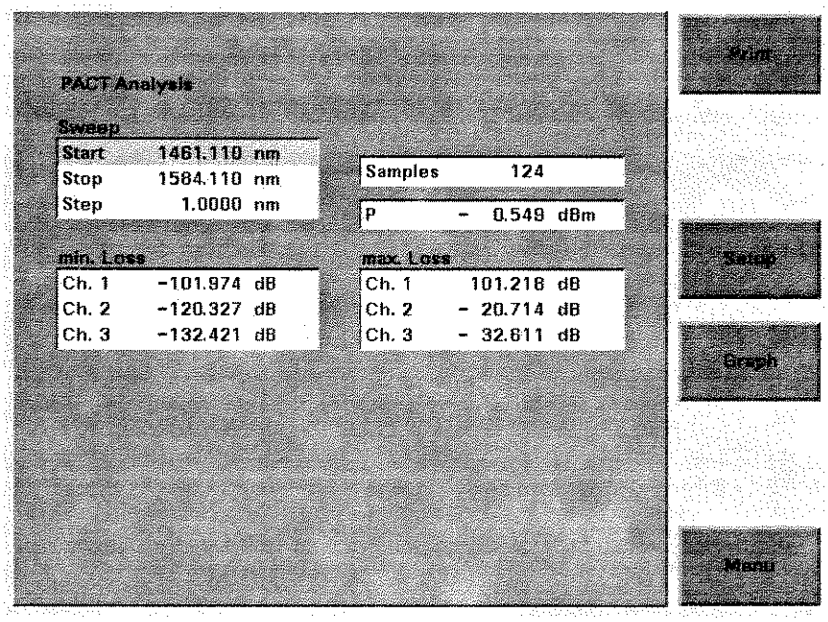



**Figure 139 The PACT Analysis Screen**

The sweep parameters are shown.

The following results of the PACT Measurement are shown for each selected Power Meter channel:

- min. Loss, the minimum loss value for the particular Power Meter channel for the sweep, and
- max. Loss, the maximum loss value for the particular Power Meter channel for the sweep.

## On-Screen Messages

The messages listed in the table below may appear at the top of the screen during the PACT application.

| HP8163A Message | HP8164A Message | Description |
|---|---|---|
| `SLck` | `SLock` | The Tunable Laser module is locked. No measurement is possible until you unlock the module, see *"How to Lock/Unlock the High-Power Laser Sources" on page 60* for details. |
| `RiLck` | `RILock` | The Remote Interlock Connector of your mainframe is open. No measurement is possible until the connection at the Remote Interlock Connector closes, see *"The Remote Interlock (RIL) connector" on page 218* for details. |
| `NoH` | `No Head` | There is an Optical Head Interface module inserted in the mainframe that does not have an Optical Head connected to it. No measurement is possible using this channel until you either:<br>• reconnect an Optical Head or<br>• deselect this Optical Head channel as a power measurement channel. |
| `NoD` | `No Data` | No data has been measured or measurement is not yet finished. You cannot access the Analysis Screen yet. Print-out and file operations are not yet possible. |
| `Set` | `Settling` | A Tunable Laser module is settling. The instrument is busy and no measurement can be performed yet. |
| `NoR` | `No Ref` | No reference sweep has been performed. Loss will be calculated using nominal laser power as a reference. |

**Table 6 PACT Application On-Screen Messages**

# The Pmax Curve

## What is the Pmax Curve ?

The Pmax Curve shows the maximum laser output power for your Tunable Laser module across the wavelength range of your Tunable Laser module.

## How to View the Pmax Curve

To view the Pmax Curve:

1 Press the *Appl* hardkey. The Applications menu, as shown in Figure 113, appears.

2 Move to <*Pmax curve*> and press *Enter*. The Pmax Curve Screen, as shown in Figure 140, appears.

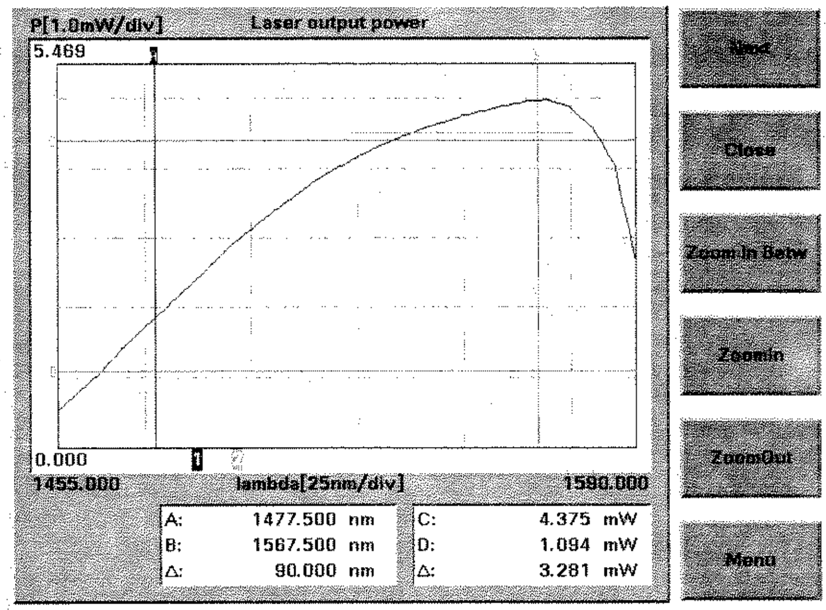



**Figure 140 The Pmax Curve Screen**

3 See *"Working with Application Graphs" on page 155* for information on zooming in and out.

4 Press [Close] to exit from the Pmax Curve application.

# Recording Measurement Results

## Printing Application Measurement Results

You can print application measurement results by completing the following instructions.

1 Perform any of the following applications as described above:

- *"The Logging Application" on page 164*,
- *"The Stability Application" on page 173*, or

- *"The PACT Application" on page 182.*

2 Move to the Analysis Screen.

3 Connect your printer to the instrument as described in *"How to Connect a Printer" on page 67.*

4 Select the printer type as described in *"How to Select the Printer Type" on page 59.*

5 Press [Menu], move to <*Print*>, and press *Enter*. The screen, shown in Figure 141, appears.

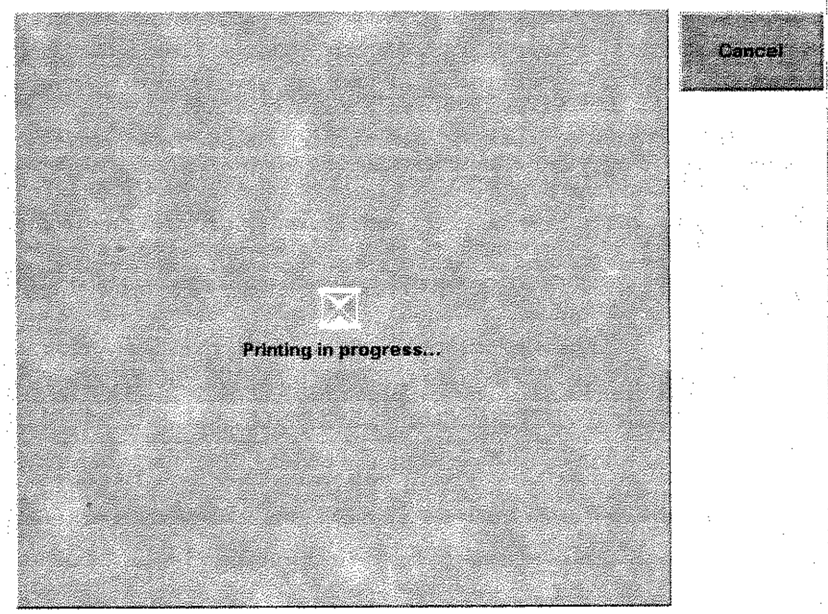



**Figure 141 The Printing in Progress Screen**

NOTE If you want to cancel the print job, press the [Cancel] softkey.

6 The printed results should resemble the page shown in Figure 142.

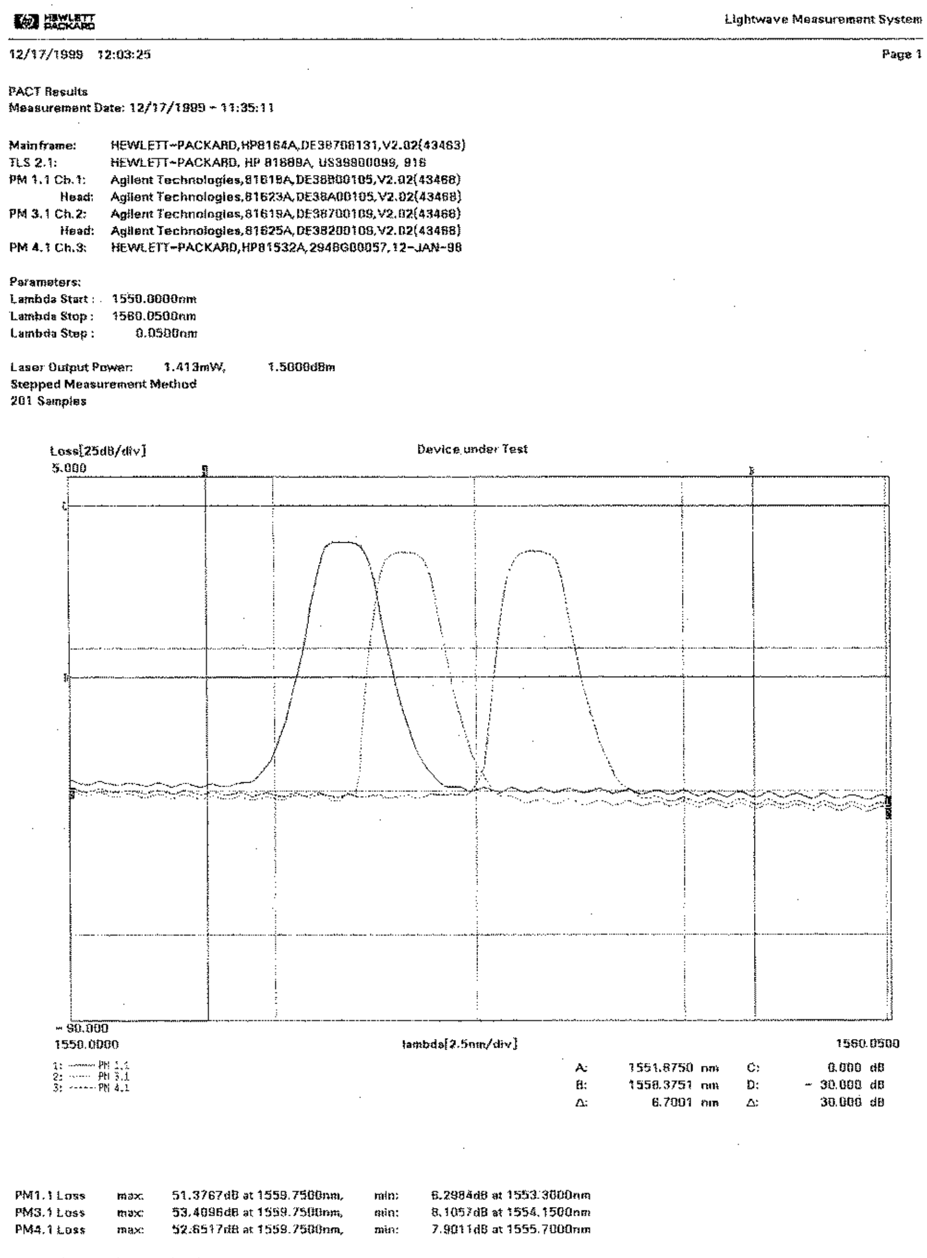



**Figure 142** **Printed Results**

# Saving Application Measurement Results to Diskette

If you are using the HP 8164A Lightwave Measurement System, you can save application measurement results to diskette by completing the following instructions:

1 Perform any of the following applications as described above:

- *"The Logging Application" on page 164*,
- *"The Stability Application" on page 173*, or
- *"The PACT Application" on page 182*.

2 Move to the Analysis Screen.

3 Insert a floppy disk in the diskette drive of your HP 8164A Lightwave Measurement System.

4 Press [Menu].

5 Move to one of the following options:

- <*Save Ascii File*>, the data will be saved in Ascii-text format, that can be opened by all text editors.
- <*Save CSV File*>, the data will be saved in CSV format, that can be opened by Microsoft Excel.

6 Press *Enter*.The File Name Editor, as shown in Figure 143, appears.

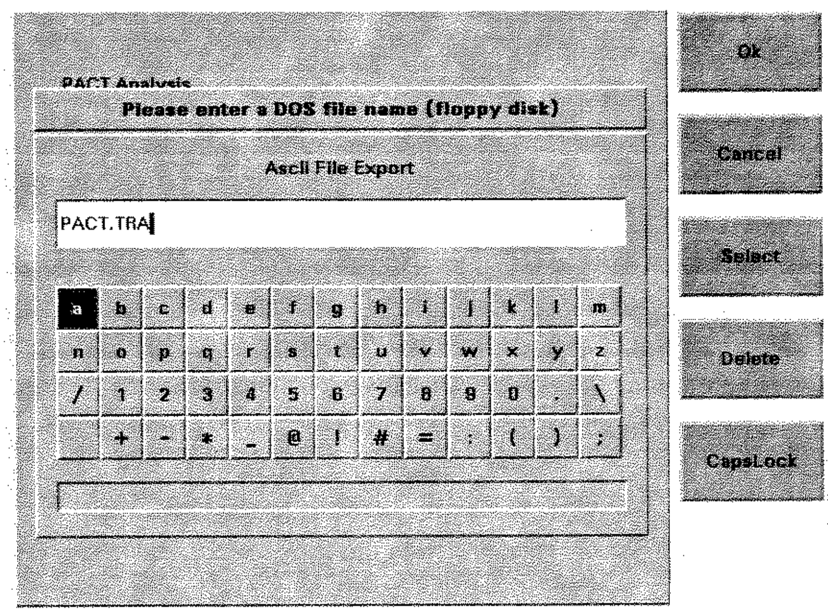



**Figure 143 The File Name Editor**

7 If you wish to change the suggested file name, use the on-screen keyboard to modify the name.

8 Press [OK] to save the data to diskette using the displayed file name.

# Installation and Maintenance

This chapter provides installation instructions for the HP 8163A Lightwave Multimeter System, HP 8164A Lightwave Measurement System, and the HP 8166A Lightwave Multichannel System. It also includes information about initial inspection and damage claims, preparation for use, packaging, storage, and shipment.

# Safety Considerations

The HP 8163A Lightwave Multimeter System, HP 8164A Lightwave Measurement System, and the HP 8166A Lightwave Multichannel System are Safety Class 1 instruments (that is, instruments with a metal chassis directly connected to earth via the power supply cable). The shown symbol is used to show a protective earth terminal in the instrument.

Before operation, review the instrument and manual for safety markings and instructions. You must follow these to ensure safe operation and to maintain the instrument in safe condition.

Some HP 8164A Lightwave Measurement System and HP 8166A Lightwave Multichannel System circuits are powered whenever the instrument is connected to the AC power source. To disconnect from the line power, disconnect the power cord either at the rear power inlet, or at the AC line power source (receptacle). One of these must always be accessible. If the instrument is in a cabinet, it must be disconnected from the line power by the system's line power switch.

# Initial Inspection

Inspect the shipping container for damage. If there is damage to the container or cushioning, keep them until you have checked the contents of the shipment for completeness and verified the instrument both mechanically and electrically.

The Function Tests give a procedure for checking the operation of the instrument. If the contents are incomplete, mechanical damage or defect is apparent, or if an instrument does not pass the operator's checks, notify the nearest Hewlett-Packard Sales/Service Office.

**WARNING** To avoid hazardous electrical shock, do not perform electrical tests when there are signs of shipping damage to any portion of the outer enclosure (covers, panels, and so on).

# AC Line Power Supply Requirements

The HP 8163A Lightwave Multimeter System can operate from the single-phase AC power source that supplies between 100 V and 240 V at a frequency in the range 50 to 60 Hz. The maximum power consumption is 120 VA with all options installed.

The HP 8164A Lightwave Measurement System can operate from any single-phase AC power source that supplies between 100 V and 240 V at a frequency in the range from 50 to 60 Hz. The maximum power consumption is 270 VA with all options installed.

The HP 8166A Lightwave Multichannel System can operate from any single-phase AC power source that supplies between 100 V and 240 V at a frequency in the range from 50 to 60 Hz. The maximum power consumption is 450 VA with all options installed.

## Line Power Cable

In accordance with international safety standards, the instrument has a three-wire power cable. When connected to an appropriate AC power receptacle, this cable earths the instrument cabinet.

**CAUTION**

Please note that the power key on the front panel of the HP 8164A Lightwave Measurement System does not stop the flow of power to the instrument. The power key allows you to switch between stand-by mode and power-on mode.

When the green power-on LED is lit, you can use the instrument. When the orange stand-by mode LED is lit, the Lightwave Measurement System is in stand-by mode. Do not remove the instrument covers - the power supply is still operating in stand-by mode.

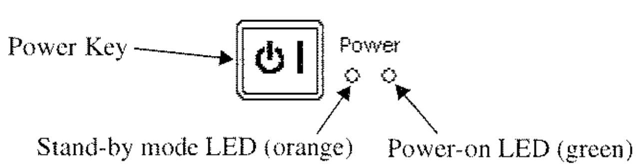



**Figure 144 HP 8164A Lightwave Measurement System Power Key**

If you need to turn off the power, unplug the instrument at the mains or remove the power cable connector from the appliance coupler at the rear of the instrument. For this reason, the power cable connection should be easily accessible - allowing you to turn off the power quickly. If the instrument is in a

cabinet, it must be disconnected from the line power by the system's line power switch.

**CAUTION**

Please note that the power key on the front panel of the HP 8166A Lightwave Multichannel System does not stop the flow of power to the instrument. The power key allows you to switch between stand-by mode and power-on mode.

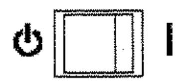


**Figure 145 HP 8166A Lightwave Multichannel System Power Key**



If you need to turn off the power, unplug the instrument at the mains or remove the power cable connector from the appliance coupler at the rear of the instrument. For this reason, the power cable connection should be easily accessible - allowing you to turn off the power quickly. If the instrument is in a cabinet, it must be disconnected from the line power by the system's line power switch.

The type of power cable shipped with each instrument depends on the country of destination. Refer to Figure 146 for the part numbers of the power cables available.

**NOTE** You only need to use the line power cable to connect to the AC adapter.

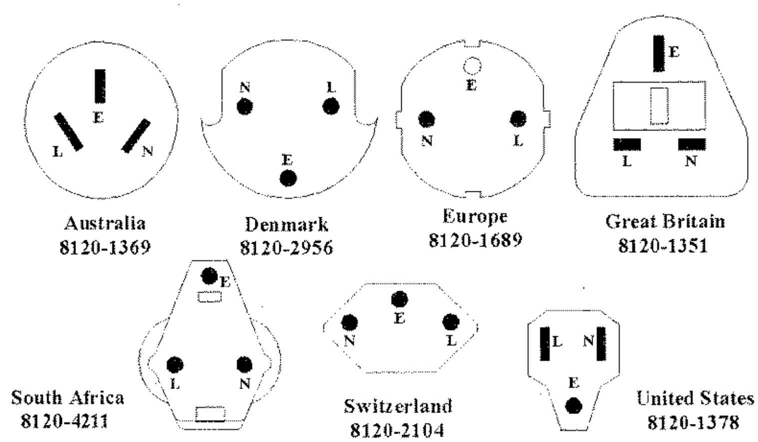



**Figure 146 Line Power Cables – Plug Identification**

**WARNING**

To avoid the possibility of injury or death, you must observe the following precautions before switching on the instrument.

- If this instrument is to be energized via an autotransformer for voltage reduction, ensure that the Common terminal connects to the earth pole of the power source.
- Insert the power cable plug only into a socket outlet provided with a protective earth contact. Do not negate this protective action by the using an extension cord without a protective conductor.
- Before switching on the instrument, the protective earth terminal of the instrument must be connected to a protective conductor. You can do this by using the power cord supplied with the instrument.
- Do not interrupt the protective earth connection intentionally.

The following work must be carried out by a qualified electrician. All local electrical codes must be strictly observed. If the plug on the cable does not fit the power outlet, or if the cable is to be attached to a terminal block, cut the cable at the plug end and rewire it.

The color coding used in the cable depends on the cable supplied. If you are connecting a new plug, it should meet the local safety requirements and include the following features:

- Adequate load-carrying capacity (see table of specifications).
- Ground connection.
- Cable clamp.

The AC power requirements are summarized on the rear panel of the instrument.

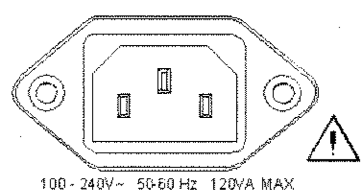



**Figure 147 AC Power Requirement Markings - HP 8163A**

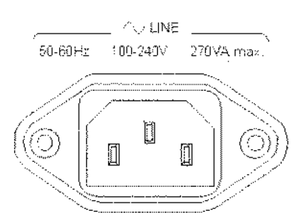



**Figure 148 AC Power Requirement Markings - HP 8164A**

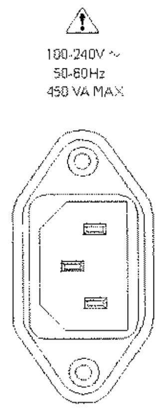



**Figure 149** **AC Power Requirement Markings - HP 8166A**

## Changing the Battery

The HP 8163A Lightwave Multimeter System, HP 8164A Lightwave Measurement System, and the HP 8166A Lightwave Multichannel System contain a lithium thionyl chloride battery. The battery is not user replaceable. The battery is protected against loading by a special circuit and must be installed with the correct polarity. Changing the battery should be carried out only by HP service personnel. If you need to get the battery replaced refer to your nearest Hewlett-Packard Sales/Service Office.

## Changing the Fuse

There is no user replaceable fuse for the HP 8163A Lightwave Multimeter System, HP 8164A Lightwave Measurement System, and the HP 8166A Lightwave Multichannel System. Changing the fuse should be carried out only by HP service personnel. If you need to get the fuse replaced refer to your nearest Hewlett-Packard Sales/Service Office.

The HP 8163A contains a F5.0A/250V fast-acting fuse.

The HP 8164A and HP 8166A contain a F10.0A/250V fast-acting fuse.

# Operating and Storage Environment

The following summarizes the operating environment ranges. In order for the HP 8163A Lightwave Multimeter System, HP 8164A Lightwave Measurement

System, and the HP 8166A Lightwave Multichannel System to meet specifications, the operating environment must be within these limits.

**WARNING** The HP 8163A Lightwave Multimeter System, HP 8164A Lightwave Measurement System, and the HP 8166A Lightwave Multichannel System are not designed for outdoor use. To prevent potential fire or shock hazard, do not expose the instrument to rain or other excessive moisture.

# Temperature

The instrument should be protected from temperature extremes and changes in temperature that may cause condensation within it.

The storage and operating temperature for the Lightwave Measurement System are given in the table below.

| Mainframe | Operating Range | Storage Range |
|---|---|---|
| **HP 8163A** | 0° C to +45° C | -40° C to +70° C |
| **HP 8164A** | +10° C to +35° C | -40° C to +70° C |
| **HP 8166A** | 0° C to +45° C | -40° C to +70° C |

**Table 7 Specified Temperature Ranges**

# Humidity

The operating humidity for the HP 8164A Lightwave Measurement System is < 80% from 10° C to +35° C.

The operating humidity for the HP 8163A Lightwave Multimeter System and the HP 8166A Lightwave Multichannel System is up to 95% from 0°C to 45°C.

# Storage and Shipment

The instrument can be stored or shipped at temperatures between -40°C and +70°C. The instrument should be protected from temperature extremes that may cause condensation within it.

# Instrument Cooling

The HP 8163A Lightwave Multimeter System and the HP 8164A Lightwave Measurement System have a cooling fan mounted internally.

The HP 8166A Lightwave Multichannel System has cooling fans mounted internally.

Mount or position your instrument upright and horizontally, as shown in Figure 150, Figure 151, or Figure 152 so that air can circulate through it freely.

## Operating Position

When operating the HP 8163A, HP 8164A, or HP 8166A choose a location that provides at least 75 mm (3 inches) of clearance at the rear, and at least 25 mm (1 inch) of clearance at each side. Failure to provide adequate air clearance may result in excessive internal temperature, reducing instrument reliability. The instrument should not be operated when mounted on its rear or side panels.

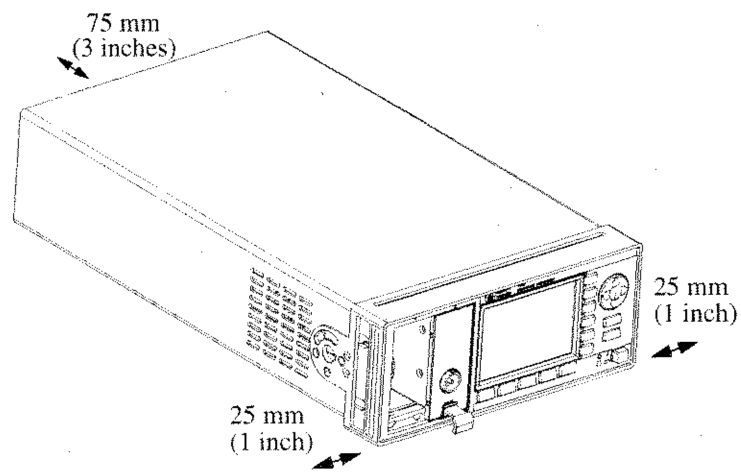



**Figure 150 Correct Operating Position of the 8163A**

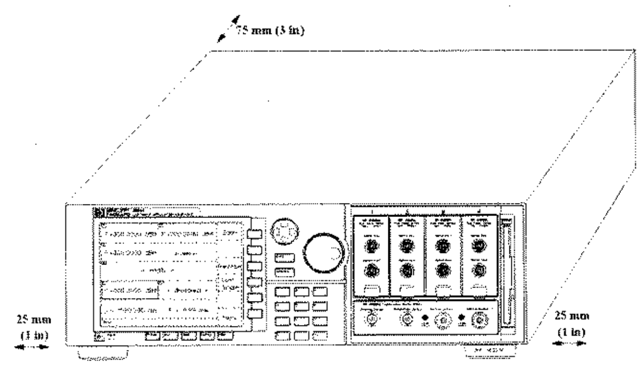



**Figure 151 Correct Operating Position of the HP 8164A**

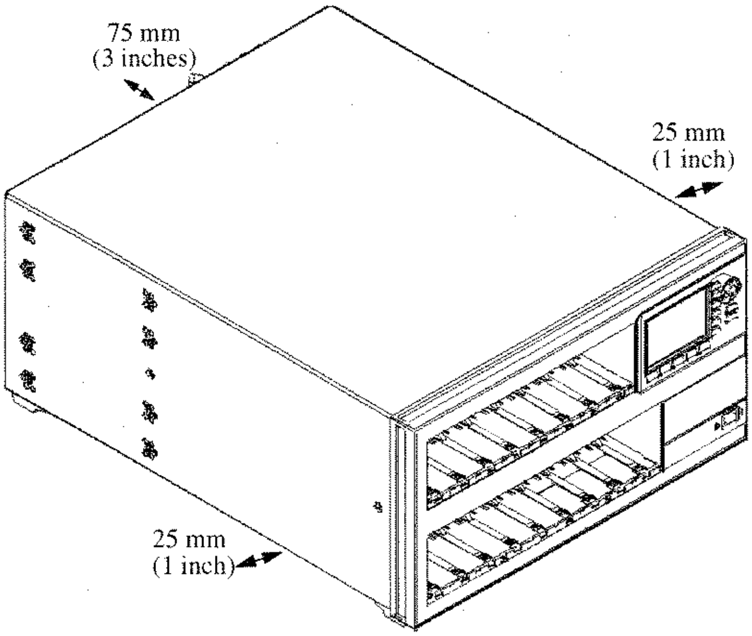



**Figure 152 Correct Operating Position of the HP 8166A**

# Storage Position

The HP 8164A Lightwave Measurement System can be stored in its operating position, as shown in Figure 150, or on its back legs as shown in Figure 153. The back legs protect the connectors on the back panel from damage.

**CAUTION** Before positioning the HP 8164A Lightwave Measurement System on its back legs:

- make sure that the instrument is in stand-by mode, see page 76 and
- disconnect all connections to the back panel.

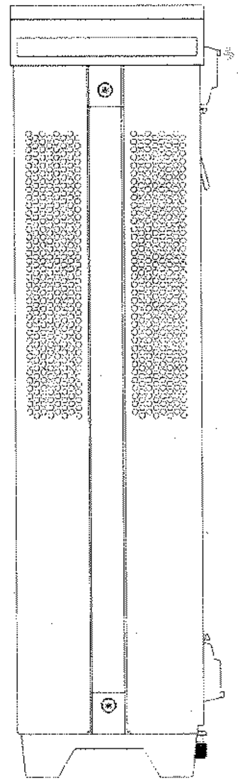


Figure 153 Storing the HP 8164A on its Back Legs.

# Carrying the Instrument

When carrrying the HP 8164A Lightwave Measurement System, grip the strap at the side of the instrument as shown in Figure 154.

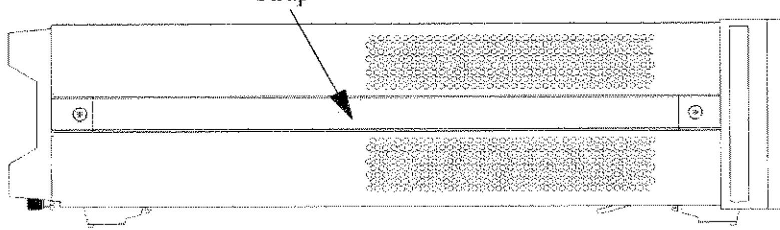



Figure 154 Carry the HP 8164A Lightwave Measurement System using this Strap

**WARNING**

If you need to lift the HP 8166A Lightwave Multichannel System ensure the following:

- that you do not attempt to lift the instrument alone, at least two people are needed to carry the instrument,
- that your back is straight and you bend your legs rather than your spine,

- that the load is as close to your body as possible,
- when carrying, you never arch your spine backwards, and
- that you can cope with the weight of your load.

# Using Modules

## How to Fit and Remove Modules

You can use two types of module:

- Front-loadable modules - these modules fit in the four module slots at the front of the HP 8164A Lightwave Measurement System or the two module slots at the front of the HP 8163A Lightwave Multimeter System or the 17 module slots at the front of the HP 8166A Lightwave Multichannel System.
- Back-loadable modules - these tunable laser source modules fit in the large module slot at the rear of the HP 8164A Lightwave Measurement System.

### How to Remove a Front-Loadable Module

**CAUTION**

Do not use the electrical or optical connectors to pull the module out of the instrument, as this can cause damage to the connectors.

Make sure that the line power is switched off before you remove a module.

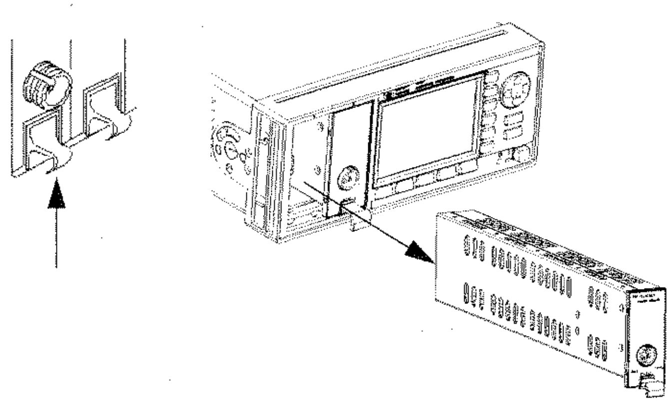


**Figure 155 How to Remove a Front-Loadable Module**

1 Lift the catch at the bottom front of the module.

2 With the catch lifted, pull the module out of the instrument. If the module does not slide out freely, check that you have lifted the catch high enough.

## How to Fit a Front-Loadable Module

**CAUTION**

Do not use the electrical or optical connectors to push the module into the instrument, as this can cause damage to the connectors.

Make sure that the line power is switched off before you fit a module.

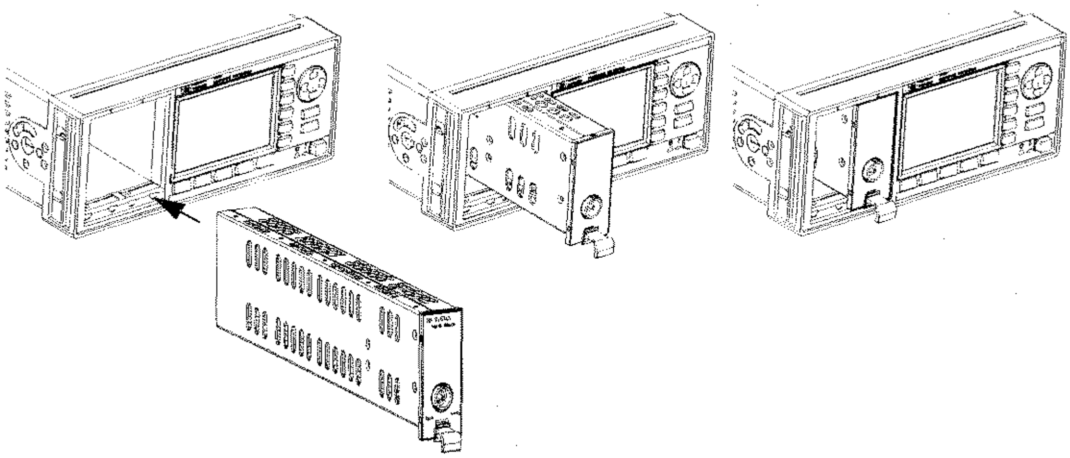


**Figure 156 How to Insert a Front-Loadable Module**

1 Position the module at an unoccupied slot, with the catch at the bottom front of the module.

2 Insert the module into the slot and onto the tracks. If the module does not slide in freely, check that you have correctly positioned and correctly oriented it and that there is no obstruction to its movement.

3 Apply pressure to the front panel, and push the module as far as it goes. You hear a small click when the module reaches its installed position. This is the catch making contact.

## How to Remove a Back-Loadable Module

**CAUTION**

Disconnect all electrical and optical connectors before you remove this module from the instrument, as this can cause damage to the connectors.

Make sure that the instrument is in stand-by mode, see page 202, before you remove a module.

1 Untighten the retaining screws, see Figure 157, that secure the module in the instrument.

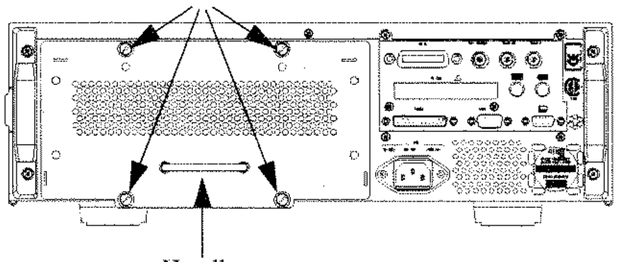



**Figure 157 Back Panel of HP 8164A Lightwave Measurement System**

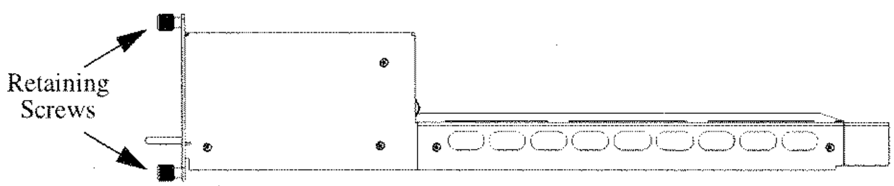



**Figure 158 Side View of a Back-Loadable Module**

2 Pull the module out of the mainframe, using the handle, being careful to keep the module completely flat.

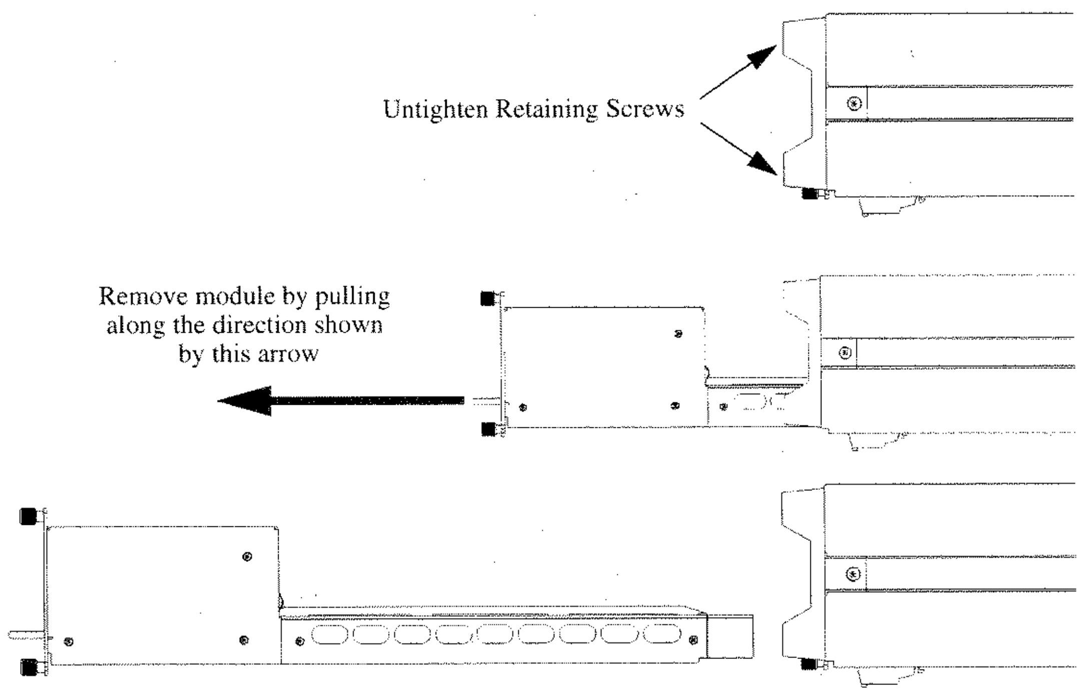



**Figure 159** **Removing a Back-Loadable Module from the HP 8164A**

**CAUTION** If you pull the module out at an angle or vertically, you may damage the instrument and the module. You should pull the module out along the direction shown by the arrow in Figure 159.

## How to Fit a Back-Loadable Module

**CAUTION** Disconnect all electrical and optical connectors before you fit this module into the instrument, as this can cause damage to the connectors.

Make sure that the instrument is in stand-by mode, see page 202. before you remove a module.

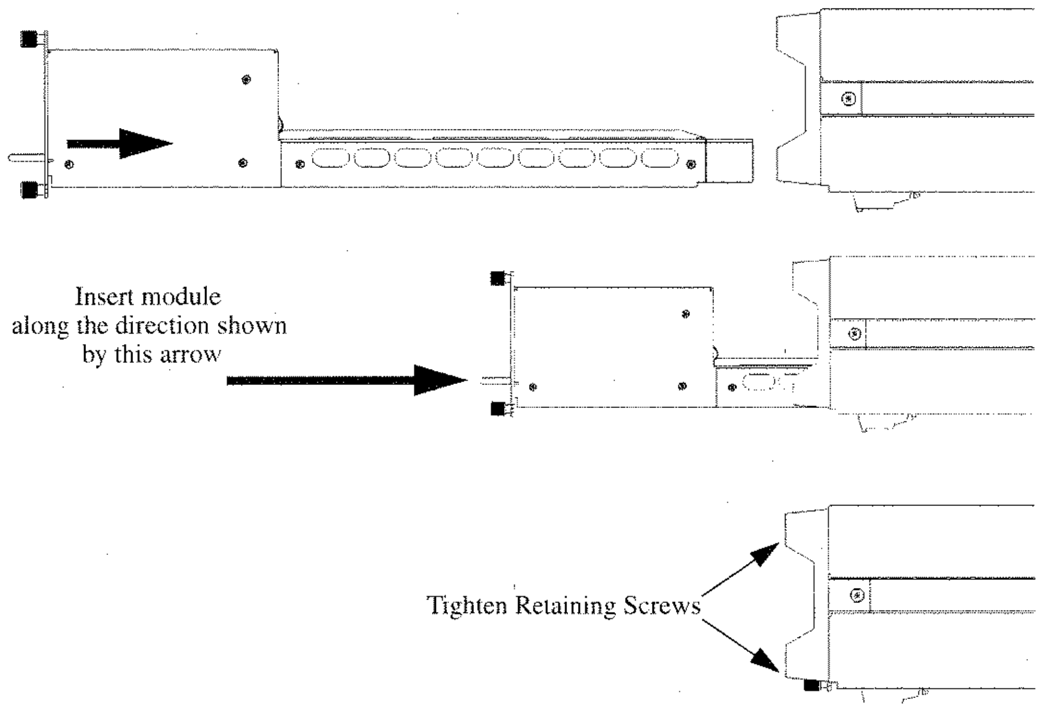



**Figure 160 Fitting a Back-Loadable Module**

1 Position the module at the rear of the instrument as shown in Figure 160.

2 Insert the module into the mainframe, using the handle, being careful to keep the module completely flat. If the module does not slide freely, check that you have correctly oriented it and that there is no obstruction to its movement.

**CAUTION**

If you insert the module at an angle or vertically, you may damage the instrument and the module. You should insert the module along the direction shown by the arrow in Figure 160.

3 Apply pressure to the handle, and push the module as far as it goes. You hear a small click when the module reaches its installed position. This is the catch making contact.

4 Tighten retaining screws, to hold module in place.

# Adding a Connector Interface

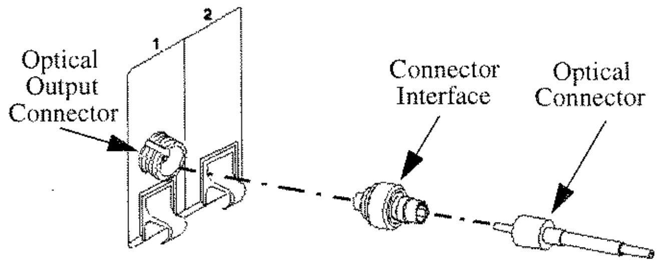



**Figure 161 Adding a Connector Interface**

NOTE Before you attach a connector and fiber, you should clean them both. See *"Cleaning Procedures" on page 261.*

To use a connector interface to connect a module to an optical-fiber patchcord connector:

1 Select a connector interface to suit the optical connector that your optical fiber is terminated with.

2 Connect the connector interface to the optical output connector of the module, see Figure 161.

3 You can now attach the optical connector to the connector interface.

# Protecting Empty Module Slots

Fitting a Blind Panel or Filler Module helps to:

- prevent dust pollution and
- optimize cooling by guiding the air flow.

## Fitting Blind Panels for Front-Loadable Module Slots

To fit the HP 08163-40199 Blind Panel, follow the following procedure.

1 Position the blind panel as shown in Figure 162. Position the end closest to the handle against the bottom edge of the slot.

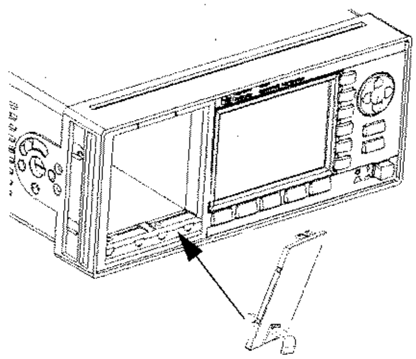


**Figure 162 Fitting a Blind Panel**

2 Push the top of the blind panel so that it clicks into position.

NOTE To remove a blind panel, pull the handle.

## Fitting a Filler Module for Back-Loadable Module Slots

The HP 81645A Filler Module must be used if you have not installed a back-loadable Tunable Laser module into the HP 8164A Lightwave Measurement System.

The HP 81645A Filler Module can be fitted in the same way as any back-loadable module, see *"How to Fit and Remove Modules" on page 210.*

The HP 81645A Filler Module can be removed in the same way as any back-loadable module, see *"How to Remove a Back-Loadable Module" on page 211.*

# Input and Output Connectors

There are three BNC connectors on the rear panel of your instrument. These are the Remote Interlock, the Trigger Out and the Trigger In connectors.

CAUTION There are two input BNC connectors: the Remote Interlock Connector and the Trigger Input, see Figure 163 or Figure 164. These are TTL inputs. A maximum of 5 V can be applied as an external voltage to either of these input connectors.

There is one output BNC connectors: the Trigger Output, see Figure 163 or Figure 164. This is a TTL output. Do not apply an external voltage to this connector.

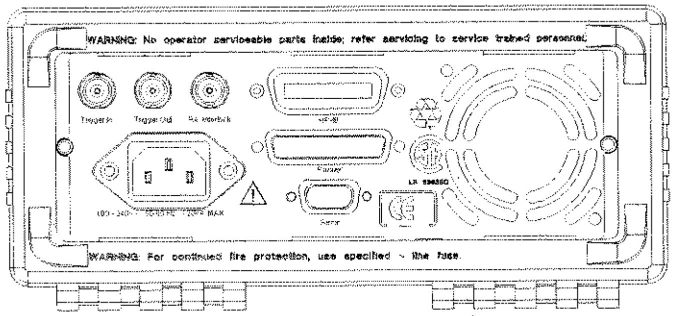



Figure 163 Rear Panel of the HP 8163A Lightwave Multimeter System

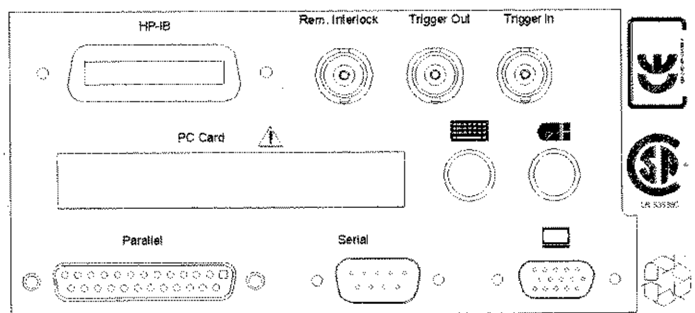



Figure 164 Rear Panel of the HP 8164A Lightwave Measurement System

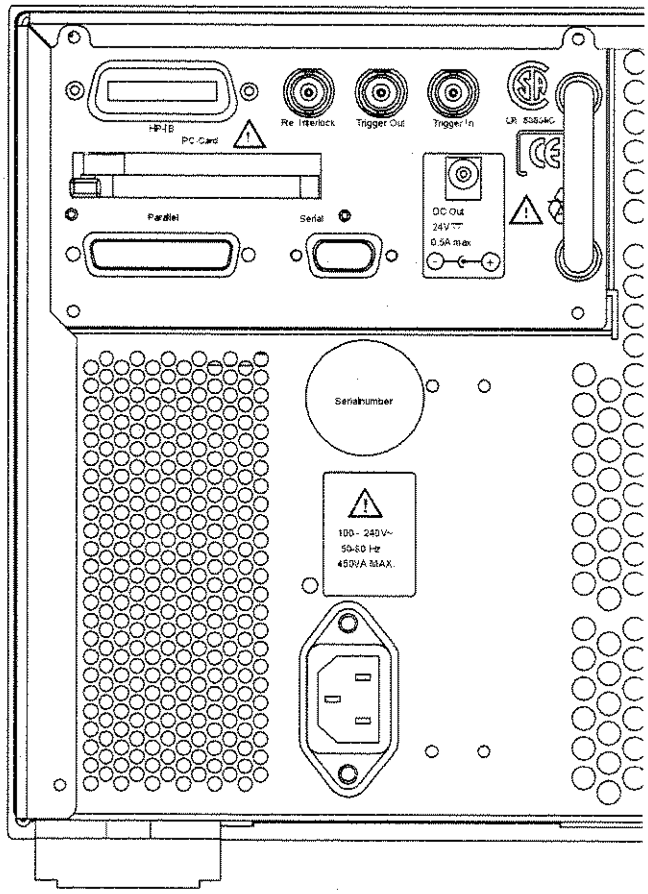



**Figure 165** **Rear Panel of the HP 8166A Lightwave Multichannel System**

# The Remote Interlock (RIL) connector

There is a Remote Interlock (RIL) connector at the back of the HP 8163A Lightwave Multimeter System, HP 8164A Lightwave Measurement System, and HP 8166A Lightwave Multichannel System. This is to protect the user from injury when using class IIIb laser sources. The use of a Remote Interlock system is specified with class IIIb laser sources by CFR 1040.10 (USA). If the short circuit at this BNC connector is opened, the laser is switched off immediately and cannot be switched on until it is closed again.

Setting the trigger configuration is explained in *"Additional Information" on page 53.*

# GPIB Interface

You can connect your GPIB interface into a star network, a linear network, or a combination star and linear network. The limitations imposed on this network are as follows:

- The total cable length cannot exceed 20 meters
- The maximum cable length per device is 2 meters
- No more than 15 devices may be interconnected on one bus.

## Cables and Adapters

The GPIB connector is compatible with the connectors on the following cables and adapter.

- GPIB Cable, 10833A, 1 m (3.3 ft.)
- GPIB Cable, 10833B, 2 m (6.6 ft.)
- GPIB Cable, 10833C, 4 m (13.2 ft.)
- GPIB Cable, 10833D, 0.5 m (1.6 ft.)
- GPIB Adapter, 10834A, 2.3 cm. extender. Use this adapter if there is no space to connect your GPIB cable directly to a GPIB interface.

## Connector

The following figure shows the connector and pin assignments.

Connector Part Number: 1251-0293

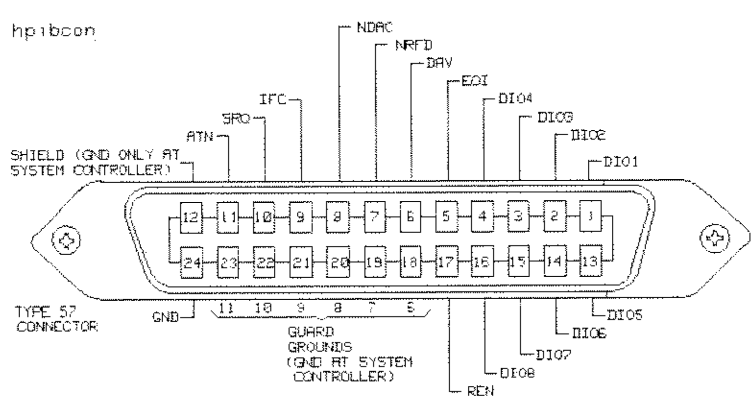



**Figure 166 GPIB Connector**

**CAUTION** HP products delivered now are equipped with connectors having ISO metric-threaded lock screws and stud mounts (ISO M3.5×0.6) that are black in color. Earlier connectors may have lock screws and stud mounts with English-threaded lock screws and stud mounts (6-32 UNC) that have a shiny nickel finish.

**CAUTION** It is recommended that you do not stack more than three connectors, one on top of the other.

Hand-tighten the connector lock screws. Do not use a screwdriver.

# GPIB Logic Levels

The instrument's GPIB lines use standard TTL logic, as follows:

- True = Low = digital ground or 0 Vdc to 0.4 Vdc
- False = High = open or 2.5 Vdc to 5 Vdc

All GPIB lines have LOW assertion states. High states are held at 3.0 Vdc by pull-ups within the instrument. When a line functions as an input, it requires approximately 3.2 mA to pull it low through a closure to digital ground. When a line functions as an output, it will sink up to 48 mA in the low state and approximately 0.6 mA in the high state.

**NOTE** The GPIB line screens are not isolated from ground.

# Claims and Repackaging

If physical damage is evident or if the instrument does not meet specification when received, notify the carrier and the nearest Agilent Technologies Sales/Service Office. The Agilent Technologies Sales/Service Office will arrange for repair or replacement of the unit without waiting for settlement of the claim against the carrier.

# Return Shipments to Agilent Technologies

If the instrument is to be shipped to a Agilent Technologies Sales/Service Office, attach a tag showing owner, return address, model number and full serial number and the type of service required.

The original shipping carton and packing material may be reusable, but the Agilent Technologies Sales/Service Office will provide information and recommendation on materials to be used if the original packing is no longer available or reusable. General instructions for repackaging are as follows:

- Wrap instrument in heavy paper or plastic.
- Use strong shipping container. A double wall carton made of 350-pound test material is adequate.
- Use enough shock absorbing material (3 to 4 inch layer) around all sides of the instrument to provide a firm cushion and prevent movement inside container. Protect control panel with cardboard.
- Seal shipping container securely.
- Mark shipping container FRAGILE to encourage careful handling.
- In any correspondence, refer to instrument by model number and serial number.

# Agilent Technologies Sales and Service Offices

For more information about Agilent Technologies test and measurement products, applications, services, and for a current sales office listing, visit our web site: http://www.agilent.com/.

# Accessories

The HP 8163A Lightwave Multimeter, the HP 8164A Lightwave Measurement System, and the HP 8166A Lightwave Multichannel System are available in various configurations for the best possible match to the most common applications.

This appendix provides information on the available options and accessories.

# Instrument and Options - HP 8163A

| Product | Opt | Description | Part Number |
|---|---|---|---|
| HP 8163A | | Lightwave Multimeter Mainframe | |
| | 0B2 | Additional User's Guide | 08164-91011 |
| | 0BF | Additional Programming Guide | 08164-91016 |
| | ABJ | Japanese User's Guide | 08164-91511 |
| | ABF | French User's Guide | 08164-91211 |
| | AB2 | Simplified Chinese (China) User's Guide | 08164-91611 |
| | AB0 | Traditional Chinese (Taiwan) User's Guide | 08164-91711 |
| | AB1 | Korean User's Guide | 08164-91811 |

## Modules

The HP 8163A Lightwave Multimeter can be used with the following module in addition to all the modules listed in "HP 8153A Lightwave Multimeter Modules" on page 229.

**Power Sensor Modules**

| Model No. | Description |
|---|---|
| HP 81632A | Sensor InGaAs, -80 dBm uncooled |
| HP 81633A | Power Sensor, -90 dBm |
| HP 81634A | Power Sensor, -110 dBm |
| HP 81635A | Dual Sensor InGaAs, -80 dBm uncooled |

**Optical Heads**

| Model No. | Description |
|---|---|
| HP 81623A | Ge Head |
| HP 81624A | InGaAs Head |
| HP 81625A | High Power Head |

Each Optical Head (HP 81623A .. HP 82625A, listed above), must include one of the following interfaces:

| Optical Head Interfaces | |
|---|---|
| **Model No.** | **Description** |
| HP 81618A | Single Channel Interface |
| HP 81619A | Dual Channel Interface |

| Accessories for Optical Heads | |
|---|---|
| **Model No.** | **Description** |
| HP 81624CE | Head extension cable |
| HP 81624DD | D-shape head adapter |
| HP 81624 RM | Head mount kit (2 heads) |

| Fabry-Perot Laser Diode Modules | |
|---|---|
| **Model No.** | **Description** |
| HP 81650A | LD Module 1310 nm |
| HP 81651A | LD Module 1550 nm |
| HP 81652A | LD Module 1550/1625 nm |
| HP 81654A | LD Module 1310/1550 nm |
| HP 81655A | LD Module hp 1310 nm |
| HP 81656A | LD Module hp 1550 nm |
| HP 81657A | LD Module 1310/1550 nm |

| Tunable Laser Source Module | |
|---|---|
| **Model No.** | **Description** |
| HP 81689A | Compact Tunable Laser for Multichannel Test Applications |

# Instrument and Options - HP 8164A

| Product | Opt | Description | Part Number |
|---|---|---|---|
| HP 8164A | | Lightwave Measurement System Mainframe | |
| | 1CN | Front Handle Kit | |
| | 1CM | Rack Mount Kit | |

| Product | Opt | Description | Part Number |
|---|---|---|---|
| | 0B2 | Additional User's Guide | 08164-91011 |
| | 0BF | Additional Programming Guide | 08164-91016 |
| | ABJ | Japanese User's Guide | 08164-91511 |
| | ABF | French User's Guide | 08164-91211 |
| | AB2 | Simplified Chinese (China) User's Guide | 08164-91611 |
| | AB0 | Traditional Chinese (Taiwan) User's Guide | 08164-91711 |
| | AB1 | Korean User's Guide | 08164-91811 |

# Modules

The HP 8164A Lightwave Measurement System can be used with the following Tunable Laser modules in addition to all the modules listed in "HP 8153A Lightwave Multimeter Modules" on page 229.

**Tunable Laser Source Modules**

| Model No. | Description |
|---|---|
| HP 81680A | Tunable Laser for the Test of Critical dense-WDM Components |
| HP 81682A | Tunable Laser for the Test of Optical Amplifiers and Passive Components |
| HP 81689A | Compact Tunable Laser for Multichannel Test Applications |
| HP 81640A | Tunable Laser for the Test of Critical Components in both dense-WDM Bands |

**Power Sensor Modules**

| Model No. | Description |
|---|---|
| HP 81632A | Sensor InGaAs 1 mm, -80 dBm uncooled |
| HP 81635A | Dual Sensor InGaAs 1 mm, -80 dBm uncooled |

# HP 81645A Filler Module

The HP 81645A Filler Module is required to operate the HP 8164A mainframe if it is used without a back-loadable Tunable Laser module. See "Fitting a Filler Module for Back-Loadable Module Slots" on page 216 for more details.

# Options

## Option 003 - HP 81682A

Built-in optical attenuator with 60 dB attenuation range.

NOTE The HP 81640A/80A Tunable Laser Source Modules have a built-in optical attenuator as standard for Output 2; the High Power output.

A built-in optical attenuator is not available for the HP 81689A.

### Option 021 - HP 81689A

Standard single mode fiber, for straight contact connectors.

### Option 022 - HP 81689A

Standard single mode fiber, for angled contact connectors.

### Option 071 - All Tunable Laser Source Modules

Polarization-maintaining fiber, Panda-type, for straight contact connectors.

### Option 072 - All Tunable Laser Source Modules

Polarization-maintaining fiber, Panda-type, for angled contact connectors.

# Instrument and Options - HP 8166A

| Product | Opt | Description |
|---|---|---|
| HP 8166A | | Lightwave Multimeter Mainframe |

## Modules

The HP 8166A Lightwave Multimeter cannot be used with any of the modules listed in "HP 8153A Lightwave Multimeter Modules" on page 229. It can only be used with the following modules:

**Power Sensor Modules**

| Model No. | Description |
|---|---|
| HP 81632A | Sensor InGaAs 1 mm, -80 dBm uncooled |
| HP 81635A | Dual Sensor InGaAs 1 mm, -80 dBm uncooled |

| Tunable Laser Source Module | |
|---|---|
| **Model No.** | **Description** |
| HP 81689A | Compact Tunable Laser for Multichannel Test Applications |

# HP 8153A Lightwave Multimeter Modules

The modules listed in this section were designed for use with the HP 8153A Lightwave Multimeter.

The HP 8163A Lightwave Multimeter and the HP 8164A Lightwave Measurement System support the use of all modules designed for the HP 8153A Lightwave Multimeter except the HP 81534A Return Loss Module, which may be supported by later firmware releases.

| Optical Heads | |
|---|---|
| **Model No.** | **Description** |
| HP 81520A | Si, +10 to −100 dBm, 450 to 1020 nm |
| HP 81521B | Ge, +3 to −80 dBm, 900 to 1700 nm |
| | *Opt 001* 0.003 dB polarization stability, +3 to −64 dBm |
| HP 81524A | InGaAs, +3 to −90 dBm, 800 to 1650 nm |
| HP 81525A | InGaAs, +27 to −70 dBm, 800 to 1650 nm |

| Optical Head Interface Modules | |
|---|---|
| **Model No.** | **Description** |
| HP 81533A | Optical Head Interface Module |
| HP 81533B | Optical Head Interface Module |

| Power Sensor Modules | |
|---|---|
| **Model No.** | **Description** |
| HP 81530A | Si, +3 to −100 dBm, 450 to 1020 nm |
| HP 81531A | InGaAs, +3 to −90 dBm, 800 to 1700 nm |

| Power Sensor Modules | |
|---|---|
| **Model No.** | **Description** |
| HP 81532A | InGaAs, +3 to −110 dBm, 800 to 1700 nm |
| HP 81536A | InGaAs, +3 to −70 dBm, 800 to 1700 nm |

| Laser Source Modules | |
|---|---|
| **Model No.** | **Description** |
| HP 81551MM | 850 nm, Multimode Laser Diode |
| HP 81552SM | 1310 nm, Single-Mode Laser Diode |
| HP 81553SM | 1550 nm, Single-Mode Laser Diode |
| HP 81554SM | 1310/1550 nm, Single-Mode Laser Diode |

| LED Source Modules | |
|---|---|
| **Model No.** | **Description** |
| HP 81542MM | 850 nm, Multimode LED Source |
| HP 81541MM | 850 nm, Multimode LED Source |

| Return Loss Module | |
|---|---|
| **Model No.** | **Description** |
| HP 81534A | InGaAs, 60/65 dB return loss range, 1250 to 1600 nm |

# GPIB Cables and Adapters

The GPIB connector is compatible with the connectors on the following cables and adapters:

- GPIB Cable, 10833A, 1 m (3.3 feet)
- GPIB Cable, 10833B, 2 m (6.6 feet).
- GPIB Cable, 10833C, 4 m (13.2 feet)
- GPIB Cable, 10833D, 0.5 m (1.6 feet)
- GPIB Adapter, 10834A, 2.3 cm extender. Use this adapter if there is no space to connect your GPIB cable directly to a GPIB interface.

# Specifications

The HP 8163A Lightwave Multimeter, the HP 8164A Lightwave Measurement System, and the HP 8166A Lightwave Multichannel System are produced to the ISO 9001 international quality system standard as part of HP's commitment to continually increasing customer satisfaction through improved quality control.

Specifications describe the instrument's warranted performance. Supplementary performance characteristics describe the instrument's non-warranted typical performance.

Because of the modular nature of the instrument, the performance specifications apply to the modules rather than the mainframe unit. The specifications for a module are supplied with that module. You should appropriate pages into this section of the manual.

# HP 8163A Specifications

The HP 8163A Lightwave Multimeter has a dual channel display.

| | | |
|---|---|---|
| **Display** | | Graphical display 190 × 300 points visible, monochrome. |
| **Display Resolution (Power Meters)** | | 0.0001 dB/dBm, 0.01 pW to 10 pW (depending on power range), up to 6.5 digits (user definable). |
| **Compatibility** | | The HP 8163A mainframe supports all HP 8153A Series and HP 8163A Series modules.[1] |
| **Data Acquisitions** | | |
| | *Memory>* | 4000 measurement results / channel |
| | *Selectable data averaging time* | depends on sensor module |
| | *Selectable total data averaging time* | 20 ms to 23:59:59 h |
| **Trigger** | | True synchronous on all channels |
| **Environmental** | | |
| | *Storage temperature* | –40°C to +70°C |
| | *Operating temperature* | 0°C to +45°C |
| | *Humidity* | <95% R.H. from 0°C to +45°C |
| **Power** | | AC 100 - 240 V ± 10%, 48 - 66 kHz, 100 VA max. |
| **Dimensions** | | 88 mm × 213 mm × 380 mm (3.5" × 8.4" × 15") |
| **Weight** | | net 4.200 kg (9.3 lbs); shipping 6.5 kg (14.5 lbs) |
| **GPIB interface** | | All modes and parameters accessible via GPIB interface |
| | *Function code* | SCPI standard [2] |
| **Interfaces** | | Parallel port (Centronics)<br>Serial port (RS232) |
| **Number of Modules** | | 2 Modules |

[1] HP 8163A Series modules are NOT compatible with the HP 8153A Lightwave Multimeter.

[2] For code compatibility to the HP 8153A Lightwave Multimeter please refer to the mainframe's Programming Guide, part number 08164-91016.

## Ordering Information

Option 908 Rack mount kit

# HP 8164A Specifications.

| | | |
|---|---|---|
| **Display** | | 600 × 400 pixels visible, active colour LCD.<br>VGA connector for external monitor. |
| **Compatibility** | | The HP 8164A mainframe supports all HP 8153A Series and HP 8163A Series modules.[1] |
| **Environmental** | | |
| | *Storage temperature* | –40° C to 70° C |
| | *Operating temperature* | 10° C to 35° C |
| | *Humidity* | < 80% R.H. from 10° C to 35° C |
| **Power** | | 100 to 240 Vrms, ± 10%, 280 VA max. |
| **Dimensions** | | 145 mm × 426 mm × 545 mm<br>(5.8" × 16.9" × 21.6") |
| **Weight** | | net, 20 kg (45 lb.), 23 kg (51 lb.), including modules. |
| **GPIB interface** | | |
| | *Function code* | SH1, AH1, T6, L4, SR1, RL1, PP0, DC2, DT0, C0. SCPI standard; [2] |
| **RS232C Interface: max. baud rate** | | 115200 bps |
| **Parallel Printer Interface** | | Centronics |
| **Number of Modules** | | 4 front-loadable Modules, 1 back-loadable Module |
| **PC-Card slot** | | PCMCIA 2.0/JEIDA 4.0 |
| **Data Storage** | | Internal Hard Disk Drive: 3250 MByte |
| | | Memory cards according to PCMCIA type I, II, and III. |
| **External Keyboard** | | PS/2 connector |

[1] HP 8163A Series modules are NOT compatible with the HP 8153A Lightwave Multimeter.

[2] For code compatibility to the HP 8153A Lightwave Multimeter please refer to the mainframe's Programming Guide, part number 08164-91016.

# HP 8166A Specifications

| | | |
|---|---|---|
| **Display** | | Graphical display 190 × 300 points visible, monochrome. |
| **Display Resolution (Power Meters)** | | 0.0001 dB/dBm, 0.01 pW to 10 pW (depending on power range), up to 6.5 digits (user definable). |
| **Compatibility** | | The HP 8166A supports all supports all HP 8163A Series modules.[1] |
| **Trigger** | | True synchronous on all channels |
| **Environmental** | | |
| | *Storage temperature* | –40°C to +70°C |
| | *Operating temperature* | 0°C to +45°C |
| | *Humidity* | <95% R.H. from 0°C to +45°C |
| **Power** | | AC 100 - 240 V ± 10%, 50 - 60 Hz, 450 VA max. |
| **GPIB interface** | | All modes and parameters accessible via GPIB interface |
| | *Function code* | SCPI standard [2] |
| **Interfaces** | | Parallel port (Centronics)<br>Serial port (RS232) |
| **Number of Modules** | | 17 Modules |
| **Dimensions** | | 240 mm × 430 mm × 580mm (9.5" × 17" × 23") |
| **Weight** | | net 23 kg (50.7 lbs); shipping 45 kg (94.8 lbs) |

[1] Modules designed for the HP 8153A Lightwave Multimeter are NOT compatible with the HP 8166A Lightwave Multichannel System.

[2] For code compatibility to the HP 8153A Lightwave Multimeter please refer to the mainframe's Programming Guide, part number 08164-91016.

## Ordering Information

Option 908 Rack mount kit

# Declaration of Conformity

## HP 8163A Lightwave Multimeter

| | | |
|---|---|---|
| | | **Lightwave Multimeter** |
| consisting of: | **HP 8163A** | Mainframe |
| and modules: | HP 81611A[1] | 1300 nm Return Loss Module |
| | HP 81612A[1] | 1550 nm Return Loss Module |
| | HP 81613A[1] | 1310/1550 nm Return Loss Module |
| | HP 81614A[1] | 1550/1625 nm Return Loss Module |
| | HP 81650A | 1310 nm Laser Source Module |
| | HP 81651A | 1550 nm Laser Source Module |
| | HP 81652A | 1550/1625 nm Laser Source Module |
| | HP 81653A | 1650 nm Laser Source Module |
| | HP 81654A | 1310/1550 nm Laser Source Module |
| | HP 81655A | 1310 nm Laser Source Module |
| | HP 81656A | 1550 nm Laser Source Module |
| | HP 81657A | 1310/1550 nm Laser Source Module |
| | HP 81689A[2] | Compact Tunable Laser for Multichannel Test Applications |

conforms to the following standards:

| | | |
|---|---|---|
| **Safety:** | IEC 1010-1:1990 incl. A1:1992+A2 (1995) | EN 61010-1:(1993) + A1. 2:1995 |
| | IEC 825-1 (1993); FDA 21 CFR 1040.10 | EN 60825-1 (1994) |

**EMC:** radiation **EN 55011:1991** / CISPR 11:1990 mod. Group 1, Class B (1)

**EMC:** immunity **EN 50082-1:1997**

| | | |
|---|---|---|
| EN 61000-4-2:1995 | ESD: | 4 kV cd. 8 kV ad. 4 kV cp |
| EN 61000-4-3: 1996 | Radiated Immunity: | 3 V/m 80% |
| ENV 50204: 1995 | Radiated Immunity: | 3 V/m 50% Duty |
| EN 61000-4-4:1995 | Fast Transients/Bursts | ±1 kV |
| EN 61000-4-5:1995 | Surges | ±1 kV; ±2 kV |
| EN 61000-4-6:1995 | Conducted Immunity | 3 V - 80% |
| EN 61000-4-8:1993 | Power freq. Field | 3A/m; 50 Hz |
| IEC 1000-4-11:1994 | Voltage Dips and Interruptions | 30%-10 ms; 60%-100 ms |

### Supplementary Information

The product herewith complies with the requirements of the

- Low Voltage Directive (73/23/EEC), and the

- EMC Directive (89/336/EEC).

The product also conforms to other standards not listed here. If you need further information on conformance to a particular standard, please contact your local Hewlett-Packard Sales and Service Office.

The product was tested in a typical configuration with HP systems (Type test).

[1] The FDA Accession Number 9920431-00

[2] The FDA Accession Number 9122175-06

| | |
|---|---|
| Böblingen, 29 April, 1999 | Wolfgang Fenske |
| Update, 15 July, 1999 | TMO-B Regulations Consultant |

# HP 8164A Lightwave Measurement System

**Manufacturer:** Hewlett-Packard GmbH
Optical Communication Measurement
Herrenberger Strasse 110-140
D-71034 Böblingen
Germany

We declare that the system:

**Lightwave Measurement System**

| | | |
|---|---|---|
| consisting of: | **HP 8164A**[1] | Mainframe |
| and modules: | HP 81611A[1] | 1300 nm Return Loss Module |
| | HP 81612A[1] | 1550 nm Return Loss Module |
| | HP 81613A[1] | 1310/1550 nm Return Loss Module |
| | HP 81614A[1] | 1550/1625 nm Return Loss Module |
| | HP 81640A[2] | Tunable Laser Module |
| | HP 81650A | 1310 nm Laser Source Module |
| | HP 81651A | 1550 nm Laser Source Module |
| | HP 81652A | 1550/1625 nm Laser Source Module |
| | HP 81653A | 1650 nm Laser Source Module |
| | HP 81654A | 1310/1550 nm Laser Source Module |
| | HP 81655A | 1310 nm Laser Source Module |
| | HP 81656A | 1550 nm Laser Source Module |
| | HP 81657A | 1310/1550 nm Laser Source Module |
| | HP 81680A[2] | Tunable Laser Module |
| | HP 81682A[2] | Tunable Laser Module |
| | HP 81689A[2] | Compact Tunable Laser for Multichannel Test Applications |

conforms to the following standards:

| | | |
|---|---|---|
| **Safety:** | IEC 1010-1:1990 incl. A1:1992+A2 (1995) | EN 61010-1:(1993) + A1. 2:1995 |
| | IEC 825-1 (1993); FDA 21 CFR 1040.10 | EN 60825-1 (1994) |

| | | | |
|---|---|---|---|
| **EMC:** radiation | **EN 55011:1991** / CISPR 11:1990 mod. Group 1, Class B (1) | | |
| **EMC:** immunity | **EN 50082-1:1997** | | |
| | EN 61000-4-2:1995 | ESD: | 4 kV cd, 8 kV ad, 4 kV cp |
| | EN 61000-4-3: 1996 | Radiated Immunity: | 3 V/m 80% |
| | ENV 50204: 1995 | Radiated Immunity: | 3 V/m 50% Duty |
| | EN 61000-4-4:1995 | Fast Transients/Bursts | ±1 kV |
| | EN 61000-4-5:1995 | Surges | ±1 kV; ±2 kV |
| | EN 61000-4-6:1995 | Conducted Immunity | 3 V - 80% |
| | EN 61000-4-8:1993 | Power freq. Field | 3A/m; 50 Hz |
| | IEC 1000-4-11:1994 | Voltage Dips and Interruptions | 30%-10 ms; 60%-100 ms |

## Supplementary Information

The product herewith complies with the requirements of the

- Low Voltage Directive (73/23/EEC), and the
- EMC Directive (89/336/EEC).

The product also conforms to other standards not listed here. If you need further information on conformance to a particular standard, please contact your local Hewlett-Packard Sales and Service Office.

The product was tested in a typical configuration with HP systems (Type test).

[1] The FDA Accession Number 9920431-00

[2] The FDA Accession Number 9122175-06

Böblingen, 29 April, 1999 — Wolfgang Fenske

Update, 15 July, 1999 — TMO-B Regulations Consultant

# HP 8166A Lightwave Multichannel System

**Lightwave Multichannel System**

| | | |
|---|---|---|
| consisting of: | **HP 8166A** | Mainframe |
| and modules: | HP 81611A[1] | 1300 nm Return Loss Module |
| | HP 81612A[1] | 1550 nm Return Loss Module |
| | HP 81613A[1] | 1310/1550 nm Return Loss Module |
| | HP 81614A[1] | 1550/1625 nm Return Loss Module |
| | HP 81650A | 1310 nm Laser Source Module |
| | HP 81651A | 1550 nm Laser Source Module |
| | HP 81652A | 1550/1625 nm Laser Source Module |
| | HP 81653A | 1650 nm Laser Source Module |
| | HP 81654A | 1310/1550 nm Laser Source Module |
| | HP 81655A | 1310 nm Laser Source Module |
| | HP 81656A | 1550 nm Laser Source Module |
| | HP 81657A | 1310/1550 nm Laser Source Module |
| | HP 81689A[2] | Compact Tunable Laser for Multichannel Test Applications |

conforms to the following standards:

| | | |
|---|---|---|
| **Safety:** | IEC 1010-1:1990 incl. A1:1992+A2 (1995) | EN 61010-1:(1993) + A1. 2:1995 |
| | IEC 825-1 (1993); FDA 21 CFR 1040.10 | EN 60825-1 (1994) |

| | | | |
|---|---|---|---|
| **EMC:** radiation | **EN 55011:1991** / CISPR 11:1990 mod. Group 1, Class B (1) | | |
| | EN 61000-3-2: 1995 | Harmonic Current | |
| | EN 61000-3-3: 1995 | Voltage Fluctuat./Flicker | |
| **EMC:** immunity | **EN 50082-1:1997** | | |
| | EN 61000-4-2:1995 | ESD: | 4 kV cd, 8 kV ad, 4 kV cp |
| | EN 61000-4-3: 1996 | Radiated Immunity: | 3 V/m 80% |
| | ENV 50204: 1995 | Radiated Immunity: | 3 V/m 50% Duty |
| | EN 61000-4-4:1995 | Fast Transients/Bursts | ±1 kV |
| | EN 61000-4-5:1995 | Surges | ±1 kV; ±2 kV |
| | EN 61000-4-6:1995 | Conducted Immunity | 3 V - 80% |
| | EN 61000-4-8:1993 | Power freq. Field | 3A/m; 50 Hz |
| | IEC 1000-4-11:1994 | Voltage Dips and Interruptions | 30%-10 ms; 60%-100 ms |

## Supplementary Information

The product herewith complies with the requirements of the

- Low Voltage Directive (73/23/EEC), and the
- EMC Directive (89/336/EEC).

The product also conforms to other standards not listed here. If you need further information on conformance to a particular standard, please contact your local Hewlett-Packard Sales and Service Office.

The product was tested in a typical configuration with HP systems (Type test).

[1] The FDA Accession Number 9920431-00

[2] The FDA Accession Number 9122175-06

Böblingen, 15 July, 1999 Wolfgang Fenske

TMO-B Regulations Consultant

# Performance Tests

These Performance Tests test the *functionality* of the instrument.

The HP 8163A Lightwave Multimeter, the HP 8164A Lightwave Measurement System, and the HP 8166A Lightwave Multichannel System comprises a power supply, a CPU, a hard-disk drive, and a display. The HP 8164A Lightwave Measurement System also has a floppy-disk drive.

The complete characteristics to which the HP 8163A Lightwave Multimeter, the HP 8164A Lightwave Measurement System, or the HP 8166A Lightwave Multichannel System is tested are given in *"Specifications" on page 231*. All tests can be performed without access to the interior of the instrument. The performance tests refer specifically to tests using the Diamond HMS-10/HP connector.

# Equipment Required

Equipment required for the Performance Test is listed in the table below. Any equipment that satisfies the critical specifications given in the table may be substituted for recommended models.

| Description | Model | | |
|---|---|---|---|
| **Mainframe, Device under Test** | HP 8163A Lightwave Multimeter | HP 8164A Lightwave Measurement System | HP 8166A Lightwave Multichannel System |
| **Laser Source** | HP 81552SM<br>(HP 81553SM)<br>(HP 81554SM) | HP 81552SM<br>(HP 81553SM)<br>(HP81554SM) | 81650A<br>(any other HP8165x series Laser Source) |
| **Power Sensor** | HP 81531A<br>(HP 81532A)<br>(HP81536A)<br>(HP 81530A)<br>(HP81533B Interface Module plus<br>HP 81524 Optical Head or HP81521B<br>or HP81525A) | HP 81531A<br>(HP 81532A)<br>(HP81533A)<br>(HP 81530A)<br>(HP81533B Interface Module plus<br>HP 81524 Optical Head or HP81521B<br>or HP81525A) | HP 81631A<br>(any other HP 8163x series Power Sensor)<br>(HP 81618A or HP 81619A Interface Module plus<br>Optical Head HP81620A or any other Optical Head from the HP8162x series) |
| NOTE | When using a high power laser source of type HP 81655A, HP 81656A, or HP 81657A, you must use an Interface Module and a high power Optical Head of type HP 81625A or HP 81626A. | | |
| **Tunable Laser Module** | N/A | HP 81640A<br>(HP 81680A)<br>(HP 81682A) | N/A |
| **Connector Adapter** | 2 x HP 81000AI<br>(depending on patchcord) | 2 x HP 81000AI<br>(depending on patchcord) | 2 x HP 81000AI<br>(depending on patchcord) |
| **Singlemode Fiber** | HP 81101AC<br>(other HP patchcord depending on DUT's conenctor option) | HP 81101AC<br>(other HP patchcord depending on DUT's conenctor option) | HP 81101AC<br>(other HP patchcord depending on DUT's conenctor option) |

**Table 8 Equipment Required for Performance Tests**

Part numbers in brackets indicate alternative models.

# Test Record

Results of the Performance Test may be tabulated in the Test Record provided after the test procedures. It is recommended that you fill out the Test Record and refer to it while doing the test. Since the test limits and set-up information are

printed on the Test Record for easy reference, the record can also be used as an abbreviated test procedure (if you are familiar with test procedures). The Test Record can also be used as a permanent record and may be reproduced without written permission from Hewlett-Packard.

## Test Failure

If the HP 8163A Lightwave Multimeter, the HP 8164A Lightwave Measurement System, or the HP 8166A Lightwave Multichannel System fail any Performance Test, return the instrument to the nearest Hewlett-Packard Sales/Service Office for repair.

## Instruments Specifications

Specifications are the characteristics of the instrument that are certified. These specifications, listed in Appendix C are the limits against which the HP 8163A Lightwave Multimeter, the HP 8164A Lightwave Measurement System, or the HP 8166A Lightwave Multichannel System can be tested. Appendix C also lists some supplemental characteristics of the HP 8163A Lightwave Multimeter, the HP 8164A Lightwave Measurement System, and the HP 8166A Lightwave Multichannel System and should be considered as additional information.

Any changes in the specifications due to manufacturing changes, design, or traceability to the National Institute of Standards and Technology will be covered in a manual change supplement or revised manual. The specifications listed here supersede any previously published.

NOTE Make sure that all optical connections of the test setups given in the procedure are dry and clean. DO NOT USE INDEX MATCHING OIL. For cleaning, use the cleaning instructions given in Appendix E.

# Performance Test Instructions

Parameters to be tested:

- Backplane Connectors by Module Performance Test
- Power Supply by Module Interaction Test
- Display by Keystroke Test

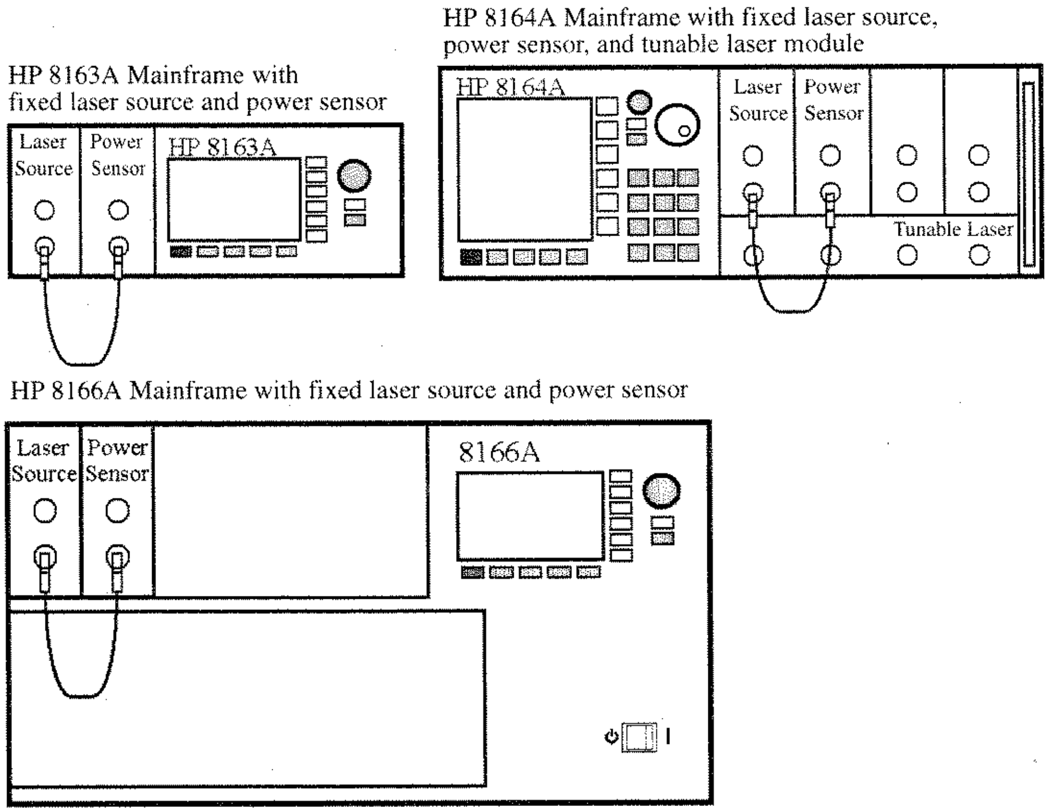



**Figure 167 Mainframe Setup**

# Display/Key Functional Test

1 Setup the test equipment as shown in Figure 167:
Insert the fixed laser source module in slot 1 and the power sensor in slot 2. If you use the HP 8164A Lightwave Measurement System, insert the back-loadable Tunable Laser module, if available, in slot 0.

2 Switch on the mainframe and wait until it has booted.

## Testing Hardkeys

3 Press *Config*. You should see the Configuration menu.

4 Press *Aux*. You should hear a "beep" and the Configuration menu should disappear.

5 Press *Appl*. You should hear a "beep".

6 Press *Help*. You should hear a "beep".

7 Press *Preset*, the green hardkey. An egg-timer icon should be displayed while all parameters are set to their default values. The Overview Screen showing all channels should appear.

8 Press *Channel* several times.
The highlighted field on the display should toggle between the channels you have inserted a module into.

## Testing the Softkeys and the Cursor Key

9 Press the right arrow of the cursor key several times.
Check the fields on the display being highlighted one after another.

10 Press the left arrow on the cursor key several times.
Check the fields on the display being highlighted one after another.

11 Press the up arrow on the cursor key several times.
Check the fields on the display being highlighted one after another.

12 Press the down arrow on the cursor key several times.
Check the fields on the display being highlighted one after another

13 Using the cursor key, move to the power parameter, [P], of the Power Sensor module.

## Testing the Softkeys and the ENTER Key

14 Press [Menu]. The menu should appear.

15 Press [Close]. The menu should disappear.

16 Press [Details]. The details screen should appear. You should see the [Cal], [Ref], and [Range] parameters in addition to [P] and [λ]. If you use the HP 8164A Lightwave Measurement System, you will also see the [Range Mode], [AvgTime], and [MinMax Mode] parameters.

17 Press [Pwr Unit]. The power unit menu should appear. Move to <dBm> using the cursor key and press *Enter*.

18 Press [Close]. The power unit menu should disappear.

19 Press [Hold/Cnt]. HOLD should appear in the channel.

20 Press [Hold/Cnt]. HOLD should disappear.

21 Press [Dsp->Ref] several times. [Ref] should update to the same value as [P] with each click.

22 Press *Preset*, the green hardkey. An egg-timer icon should be displayed while all parameters are set to their default values. The Overview Screen showing all channels should appear.

## Testing the the Modify Knob

NOTE The Modify Knob is only available if you use the HP 8164A.

23 Turn the Modify Knob clockwise.
Check the fields on the display being highlighted one after another.

24 Turn the Modify Knob counter clockwise.
Check the fields on the display being highlighted one after another.

25 Using the Modify Knob, move to the [λ] parameter of the power sensor (that is, channel 2, right field).

26 Press the Modify Knob. The first digit left of the period should be highlighted.

27 Press [Cancel].

28 Press *Preset*, the green hardkey, to return to the Overview Screen.

## Testing the Number Keys

NOTE Number Keys are only available if you use the HP 8164A.

29 Using the cursor keys, move to the [P] parameter of the sensor channel, that is channel 2. Press [Details].

30 Using the cursor keys, move to [*Cal*], and press *Enter*. The first digit left of the period should be highlighted.

31 Using the number keys press the following sequence: 1, 2, 3, 4, 5, and 6. 123.456 dB should be displayed as the [*Cal*] value.

32 Press *Enter* twice to get access to the [*Cal*] field again

33 Using the number keys press the following sequence: 1, 2, ., 7, 8, and 9. 10.789 dB should be displayed as the [*Cal*] value.

34 Press [+/−] several times. The [*Cal*] field should toggle between 10.789 dB and −10.789 dB.

35 Press *Preset*, the green hardkey, to return to the Overview Screen.

# Module Interaction Test

NOTE The following functional test assumes the use of modules which are within specification.

1 Setup the test equipment as shown in Figure 167:
Insert the fixed laser source module in slot 1 and the power sensor in slot 2 . If you use the HP 8164A Lightwave Measurement System, insert the back-loadable Tunable Laser module, if available, in slot 0.

2 Switch on the mainframe and wait until it has booted.

3 Press *Preset*, the green hardkey, to set all parameters to their default values.

4 Ensure that [λ], the wavelength of the power sensor module equals [λ], the wavelength of the laser source in slot 1.

5 Ensure, the attenuation of the laser source is set to 0.00 dB.

6 Move to the power sensor channel, move to [P], press [*Power Unit*], and select <*dBm*> from the menu that appears.

7 Press the key beside the laser output on the module front panel to switch on the laser source.

8 Note the power reading of the power sensor in the test record. The Module Interaction Test ends here if you use the HP 8163A.

NOTE If you use the HP 8164A, perform steps 9 to 12.
If you use the HP 8166A, perform steps 9 to 15.

9 Switch your mainframe off, by pressing the Power Key.

10 Move the laser source module from slot 1 to slot 3, and the power sensor module from slot 2 to slot 4.

11 Connect the output of the laser source in slot 3 to the input of the power sensor in slot 4.

12 Repeat step items 2 to 8.

13 Move the laser source to a slot with an odd number and the power sensor to the following slot with an even number. For the last test, leave the source in slot 15 and move the power sensor to slot 17.

14 Connect the output of the laser source to the input of the power sensor.

15 Repeat step items 2 to 8.

## Test of the Tunable Laser Module Channel (Slot 0)

If you need to test a back-loadable Tunable Laser module slot, perform the remaining list items. This test only applies to the HP 8164A Lightwave Measurement System.

16 Connect the power output of the Tunable Laser module to the input of the power sensor.

17 Switch on the HP 8164A and wait until is has booted.

18 Press *Preset*, the green hardkey, to set all parameters to their default values.

19 Move to [λ], the wavelength of your Tunable Laser module, type 1550.00.

20 Move to [λ], the wavelength of your power sensor, type 1550.00.

21 Set the [P], the output power, and [Att], the attenuation, to the value given in Table 9.

| Tunable Laser Module | Attenuation [ATT] | Power [P] |
|---|---|---|
| HP 81680A, Output 2, High Power | 0 dB | –10.00 dBm |
| HP 81682A | Not applicable | 0.00 dBm |

**Table 9 Reference Wavelength and Power Settings**

| Tunable Laser Module | Attenuation [ATT] | Power [P] |
|---|---|---|
| HP 81682A #003 | 0 dB | −10.00 dBm |
| HP 81640A, Output 2, High Power | 0 dB | −10.00 dBm |

**Table 9 Reference Wavelength and Power Settings**

**22** Note the power reading of the power sensor in the test record.

# GPIB Interface Test (Optional)

You will need a controller/computer with GPIB capabilities for this test.

**1** Connect the HP 8163A Lightwave Multimeter or the HP 8164A Lightwave Measurement System to the controller via the GPIB.

**2** Switch on the instrument and wait until it has booted.

**3** Send the `*IDN?` query to the instrument from the controller.

**4** Check that the lowest softkey is called [Local]. This indicates that the instrument received the query.

**5** The reply from the instrument should be a string of the form,

```
HEWLETT-PACKARD, <Model Number>, <Serial Number>,
<Firmware Revision Number>
```

**6** Press [Local] to return the instrument to local control.

# Test Record

## HP 8163A Lightwave Multimeter Performance Test

Page 1 of 2

| | | | |
|---|---|---|---|
| **Model** | HP 8163A Lightwave Multimeter | **Date** | ________ |
| **Serial No.** | ______________ | **Ambient Temperature** | ________°C |
| **Options** | ______________ | **Relative Humidity** | ________% |
| **Firmware Rev.** | ______________ | **Line Frequency** | ________Hz |

| | | | |
|---|---|---|---|
| **Test Facility** | ______________ | **Customer** | ______________ |
| **Performed by** | ______________ | **Report No** | ______________ |

**Special Notes** ________________________________

## HP 8163A Lightwave Multimeter Performance Test

Page 2 of 2

HP 8163A Serial No.__________ Trace No.__________ Date__________

### Test Equipment Used

| | Description | Model No. | Trace No | Cal. Due Date |
|---|---|---|---|---|
| 1 | CW Laser Source | ________ | ________ | ________ |
| 2 | Optical Power Sensor | ________ | ________ | ________ |
| 3 | Opt. Head Interface Module | ________ | ________ | ________ |
| 4 | Optical Head | ________ | ________ | ________ |
| 5 | ________ | ________ | ________ | ________ |
| 6 | ________ | ________ | ________ | ________ |
| 7 | ________ | ________ | ________ | ________ |
| 8 | ________ | ________ | ________ | ________ |
| 9 | ________ | ________ | ________ | ________ |
| 10 | ________ | ________ | ________ | ________ |
| 11 | ________ | ________ | ________ | ________ |
| 12 | ________ | ________ | ________ | ________ |
| 13 | ________ | ________ | ________ | ________ |
| 14 | ________ | ________ | ________ | ________ |
| 15 | ________ | ________ | ________ | ________ |

| **Display / Key Function Test** | **Check the appropriate function** | |
|---|---|---|
| | Passed | Failed |
| Test of the Hardkeys | ________ | ________ |
| Test of the Softkeys | ________ | ________ |
| Test of the Cursor Key | ________ | ________ |

**Module Interaction Test** — **Check the appropriate function**

| Test of | Min Spec | Result | Max Spec | Passed | Failed |
|---|---|---|---|---|---|
| Slot 1 and Slot 2 | - 6 dBm | ________ | + 6 dBm | ________ | ________ |

| **GPIB Interface Test** | **Check the appropriate function** | |
|---|---|---|
| | Passed | Failed |
| GPIB Interface Test | ________ | ________ |

# HP 8164A Lightwave Measurement System Performance Test



| | | | |
|---|---|---|---|
| **Model** | HP 8164A Lightwave Measurement System | **Date** | ________ |
| **Serial No.** | ________ | **Ambient Temperature** | ________°C |
| **Options** | ________ | **Relative Humidity** | ________% |
| **Firmware Rev.** | ________ | **Line Frequency** | ________Hz |

| | | | |
|---|---|---|---|
| **Test Facility** | ________ | **Customer** | ________ |
| **Performed by** | ________ | **Report No** | ________ |

**Special Notes** ________________________________

**HP 8164A Lightwave Measurement System Performance Test**

Page 2 of 3

HP 8164A Serial No.__________ Trace No.__________ Date__________

**Test Equipment Used**

| | Description | Model No. | Trace No | Cal. Due Date |
|---|---|---|---|---|
| 1 | CW Laser Source | ________ | ________ | ________ |
| 2 | Optical Power Sensor | ________ | ________ | ________ |
| 3 | Opt. Head Interface Module | ________ | ________ | ________ |
| 4 | Optical Head | ________ | ________ | ________ |
| 5 | Tunable Laser Module | ________ | ________ | ________ |
| 6 | ________ | ________ | ________ | ________ |
| 7 | ________ | ________ | ________ | ________ |
| 8 | ________ | ________ | ________ | ________ |
| 9 | ________ | ________ | ________ | ________ |
| 10 | ________ | ________ | ________ | ________ |
| 11 | ________ | ________ | ________ | ________ |
| 12 | ________ | ________ | ________ | ________ |
| 13 | ________ | ________ | ________ | ________ |
| 14 | ________ | ________ | ________ | ________ |
| 15 | ________ | ________ | ________ | ________ |
| 16 | ________ | ________ | ________ | ________ |

**HP 8164A Lightwave Measurement System Performance Test**

Page 3 of 3

HP 8164A Serial No.__________ Trace No.__________ Date__________

| **Display / Key Function Test** | **Check the appropriate function** | |
|---|---|---|
| | Passed | Failed |
| Test of the Hardkeys | ________ | ________ |
| Test of the Softkeys | ________ | ________ |
| Test of the Cursor Key | ________ | ________ |
| Test of the Modify Knob | ________ | ________ |
| Test of the Number Keys | ________ | ________ |

**Module Interaction Test** — **Check the appropriate function**

| Test of | Min Spec | Result | Max Spec | Passed | Failed |
|---|---|---|---|---|---|
| Slot 1 and Slot 2 | - 6 dBm | ________ | + 6 dBm | ________ | ________ |
| Slot 3 and Slot 4 | - 6 dBm | ________ | + 6 dBm | ________ | ________ |
| **Slot 0 (Optional)** | | | | | |
| Using HP 81680A | - 16 dBm | ________ | – 4 dBm | ________ | ________ |
| Using HP 81682A, std | - 6 dBm | ________ | + 6 dBm | ________ | ________ |
| Using HP 81682A, #003 | - 16 dBm | ________ | – 4 dBm | ________ | ________ |
| Using HP 81640A | - 16 dBm | ________ | – 4 dBm | ________ | ________ |

| **GPIB Interface Test** | **Check the appropriate function** | |
|---|---|---|
| | Passed | Failed |
| GPIB Interface Test | ________ | ________ |

# HP 8166A Lightwave Multichannel System Performance Test

Page 1 of 3

| | | | |
|---|---|---|---|
| **Model** | HP 8166A Lightwave Multichannel System | **Date** | ________ |
| **Serial No.** | ________________ | **Ambient Temperature** | ________°C |
| **Options** | ________________ | **Relative Humidity** | ________% |
| **Firmware Rev.** | ________________ | **Line Frequency** | ________Hz |
| **Test Facility** | ________________ | **Customer** | ________________ |
| **Performed by** | ________________ | **Report No** | ________________ |

**Special Notes** ________________________________________

**HP 8166A Lightwave Multichannel System Performance Test**

Page 2 of 3

HP 8166A Serial No.__________ Trace No.__________ Date__________

**Test Equipment Used**

| | Description | Model No. | Trace No | Cal. Due Date |
|---|---|---|---|---|
| 1 | CW Laser Source | | | |
| 2 | Optical Power Sensor | | | |
| 3 | Opt. Head Interface Module | | | |
| 4 | Optical Head | | | |
| 5 | | | | |
| 6 | | | | |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |
| 10 | | | | |
| 11 | | | | |
| 12 | | | | |
| 13 | | | | |
| 14 | | | | |
| 15 | | | | |
| 16 | | | | |

**HP 8166A Lightwave Multichannel System Performance Test**

Page 3 of 3

HP 8166A Serial No.__________ Trace No.__________ Date__________

**Display / Key Function Test** — **Check the appropriate function**

| | Passed | Failed |
|---|---|---|
| Test of the Hardkeys | ______ | ______ |
| Test of the Softkeys | ______ | ______ |
| Test of the Cursor Key | ______ | ______ |

**Module Interaction Test** — **Check the appropriate function**

| Test of | Min Spec | Result | Max Spec | Passed | Failed |
|---|---|---|---|---|---|
| Slot 1 and Slot 2 | - 6 dBm | ______ | + 20 dBm | ______ | ______ |
| Slot 3 and Slot 4 | - 6 dBm | ______ | + 20 dBm | ______ | ______ |
| Slot 5 and Slot 6 | - 6 dBm | ______ | + 20 dBm | ______ | ______ |
| Slot 7 and Slot 8 | - 6 dBm | ______ | + 20 dBm | ______ | ______ |
| Slot 9 and Slot 10 | - 6 dBm | ______ | + 20 dBm | ______ | ______ |
| Slot 11 and Slot 12 | - 6 dBm | ______ | + 20 dBm | ______ | ______ |
| Slot 13 and Slot 14 | - 6 dBm | ______ | + 20 dBm | ______ | ______ |
| Slot 15 and Slot 16 | - 6 dBm | ______ | + 20 dBm | ______ | ______ |
| Slot 15 and Slot 17 | - 6 dBm | ______ | + 20 dBm | ______ | ______ |

**GPIB Interface Test** — **Check the appropriate function**

| | Passed | Failed |
|---|---|---|
| GPIB Interface Test | ______ | ______ |

# Cleaning Procedures

In general, *whenever possible use physically contacting connectors, and dry connections.* Fiber connectors may be used dry or wet. Dry means without index matching compound. Clean the connectors, interfaces and bushings carefully each time after use.

**WARNING**

Make sure to disable all sources when you are cleaning any optical interfaces. Under no circumstances look into the end of an optical cable attached to the optical output when the device is operational.
The laser radiation is not visible to the human eye, but it can seriously damage your eyesight.

# Cleaning Materials

| | HP P/N |
|---|---|
| Lens Cleaning Paper | 9300-0761 |
| Special Cleaning Tips | 9300-1351 |
| Blow Brush | 9300-1131 |
| Adhesive Cleaning tape | 15475-68701 |
| Isopropyl Alcohol | Not available from HP. This should be available from any local pharmaceutical supplier. |
| Pipe Cleaner | |

**Table 10 Required Cleaning Materials**

**WARNING**

To prevent electrical shock, disconnect the Lightwave Measurement System from the mains before cleaning. Use a dry cloth or one slightly dampened with water to clean the external case parts. Do not attempt to clean internally.

# Cleaning Instrument Housing

Use a dry and very soft tissue to clean the instrument housing and the keypad. Do not open the instrument as there is a danger of electric shock, or electrostatic discharge. Opening the instrument can cause damage to sensitive components, and in addition your warranty will be voided.

# Cleaning Fiber/Panel Connectors

1 To clean the instrument panel connector remove the connector interface.
2 Apply some isopropyl alcohol to the lens cleaning paper and clean the surface and the ferrule of the connectors.

3 Using a new dry piece of cleaning paper, wipe the connector surface and ferrule until they are dry and clean.

4 Lightly press the adhesive tape several times against the connector surface to remove any remaining particles. After use store the tape in the container.

5 Protect the connector surface with a cap.

# Cleaning Connector Interfaces

NOTE If any index matching compound was used, use an ultrasonic bath with isopropyl alcohol to clean the connector interfaces.

- Apply some isopropyl alcohol to the pipe cleaner and wash the inside the connector interface.
- Using a new dry pipe cleaner, dry the inside the connector interface.
- Remove the brush part from the blow brush and blow air through the inside the interface to remove any remaining particles.

# Cleaning Connector Bushings

As used on the HP 8158B Optical Attenuator and HP 81000AS/BS Optical Power Splitter.

Normally the connector bushings require no cleaning. However, if it appears that cleaning is necessary, use only the blow brush with the brush part removed.

CAUTION NEVER insert any cleaning tool into the bushing as this may affect the optical system.
NEVER use any index matching compound, cleaning fluid or cleaning spray.

# Cleaning Detector Windows

As used on the HP 81520A and HP 81521B Optical Heads (large area).

1 Use the blow brush to remove any particles from the surface.

2 Wipe the surface with cleaning paper or special cleaning tips.

# Cleaning Lens Adapters

**CAUTION** Do not use any cleaning fluid or cleaning spray.

1 Using the blow brush, remove dust.

2 Wipe the surfaces with the special cleaning tips.

# Cleaning Detector Lens Interfaces

As used on the HP 81522A Optical Head (small area) and HP 8140A and HP 8153A detector modules.

Normally, the lens interface can be cleaned by using the blow brush. If adhesive dirt must be removed perform as follows:

1 Using the blow brush, remove the dust from the lens surface.

2 Press the special cleaning tip to the lens surface and rotate the tip.

**NOTE** Use alcohol for cleaning only when the above procedure does not help or if the dirt is caused by oil or fat.

# Firmware Upgrades

This chapter provides information about the firmware upgrade process for the HP 8163A Lightwave Multimeter, the HP 8164A Lightwave Measurement System, and the HP 8166A Lightwave Multichannel System.

# Firmware Upgrade Process

You may need to upgrade firmware because:

- You may need to use new modules that cannot work without the newest firmware. Your instrument will generate an error message if you try to insert a module that is not supported by your instrument's current firmware.
- New revisions of the HP 816x VXI*plug&play* Instrument Driver require the newest firmware revision. The HP 816x VXI*plug&play* Instrument Driver is supplied on the same Support Disk as firmware upgrades.
- To enhance the usability and functionality of your instrument. New features may be available with new firmware revisions.

## How to Get a Firmware Upgrade

### Receive a Support Disk with New Modules

The latest edition of the Support Disk is shipped with all modules and mainframes. The Support Disk is a compact disk that contains the latest revisions of the following software and utilities:

- Firmware Upgrades for mainframes and modules,
- the HP 816x VXI*plug&play* Instrument Driver, and
- User's Guides for mainframes and modules, including the Programming Guide.

### Download Firmware Upgrade from Internet

You can also download, free of charge, the new Firmware Upgrade for your instrument by accessing http://www.agilent.com/, clicking on <Services and Support> on the left-hand side of the screen, clicking on <Technical Support> underneath the "Test and Measurement" heading, clicking on <Software Updates and Firmware Upgrades>, and then clicking on <Fiber Optic Test Equipment Software and Firmware Upgrades>.

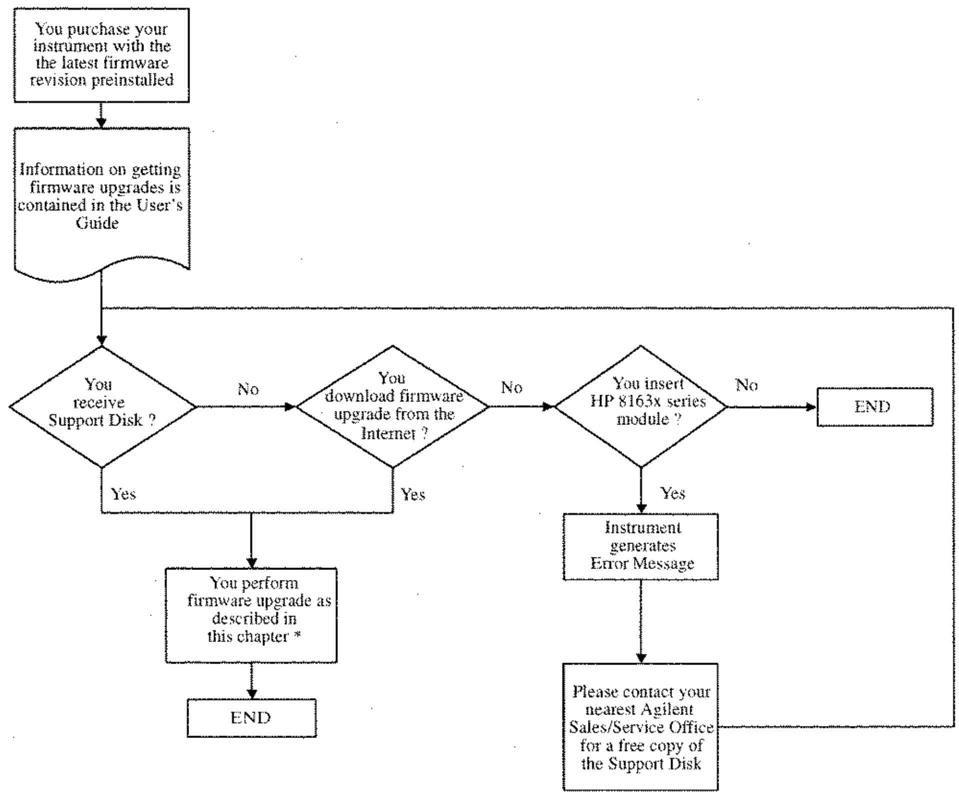



**Figure 168 Firmware Upgrade Flow Chart**

# How to Upgrade Firmware

You can receive a firmware upgrade on the following media:

- as a download from the internet, or
- on CD-ROM.

## How to Upgrade Firmware from the Internet

You can download the firmware upgrade from the Internet. See the webpage for further information on installing the firmware.

## How to Upgrade Firmware from CD-ROM

If the instrument's firmware is supplied to you on CD-ROM, insert the CD-ROM in the CD-ROM drive of your personal computer and follow the procedure for your instrument as described below.

## HP 8163A Firmware Upgrade Procedure

To upgrade firmware for the HP 8163A, you require a PC, running MS Windows 95 or NT 4.0, or higher, plus a serial null-modem cable, that was supplied with your HP 8163A mainframe.

Perform the following instructions:

1. Copy the directory Firmware/8163A from the Support Disk to a directory on your PC. This directory contains the files "HPFlashWinR5.exe" and "63_fl202.bin".
2. Click on HPFlashWinR5.exe to start the HPFLASH software.
3. Press the "File Selection" button, the file selection box appears.
4. Move to the file "63_fl202.bin" and click on OK.
5. Click on 'Port Settings'.
6. Select the com port where the serial cable is connected. Choose the maximum baud rate. Click on OK.
7. Turn on the 8163A and wait for the first beep.

   Now you must be quick:

   - Press and hold the *Preset* hardkey.
   - Still holding *Preset*, press and hold the *Aux* hardkey.
   - Still holding *Preset* and *Aux*, press and hold the *Appl* hardkey.

**TIP** Use three fingers and place them near the keys in advance!

   If you were successful, you here a double beep and the display shows that the instrument is in download mode. Otherwise, turn off the power and try again.

8. Click on 'Program' and wait until the download completes. The instrument will reboot with the new firmware.

## HP 8164A Firmware Upgrade Procedure

To upgrade firmware for the HP 8164A, you require two empty floppy disks.

Perform the following instructions:

1. Copy the directory Firmware/8164A from the Support Disk to a directory on your PC. This directory contains the files "copydisk.exe", "64_202_1.img", and "64_202_2.img".
2. Format the two two floppy disks (3.5", 1.44 MByte) with your PC, and label them as DISK_1 and DISK_2.
3. Insert the DISK_1 into your PC and open a DOS command window if you are running Windows.
4. Copy the first firmware image file to DISK_1 using the command "copydisk.exe 64_202_1.img a:".

**NOTE** In step 4 and step 6, we presume your diskette drive is "a:". If not, adjust the copydisk.exe command accordingly.

**5** Insert the DISK_2 into your PC and open a DOS command window if you are running Windows.

**6** Copy the second firmware image file to DISK_2 using the command "copydisk.exe 64_202_2.img a:".

**7** Insert DISK_1 into the mainframe.

**8** Turn on the 8164A and wait for the first beep.

Now you must be quick:

- Press and hold the *Preset* hardkey.
- Still holding *Preset*, press and hold the *Aux* hardkey.
- Still holding *Preset* and *Aux*, press and hold the *Appl* hardkey.

**TIP** Use three fingers and place them near the keys in advance!

If you were successful, you here a double beep and the display shows that the instrument is in download mode. Otherwise, turn off the power and try again.

**9** Follow the instructions that appear on the screen.

**10** Insert Disk_2 when requested to insert the disk containing the file "firmware.2".

**11** After the programming finishes, cycle the power. The instrument will reboot with the new firmware. Don't forget to remove DISK_2.

## HP 81640A/80A/82A Firmware Upgrade Procedure

To upgrade firmware for your HP 81640A/80A/82A Tunable Laser module, you require two empty floppy disks.

Perform the following instructions:

**1** Copy the directory Tunable Laser Modules to a directory on your PC. This directory contains the files "copydisk.exe", "64m202_1.img", and "64m202_2.img".

**2** Format the two two floppy disks (3.5", 1.44 MByte) with your PC, and label them as DISK_1 and DISK_2.

**3** Insert the DISK_1 into your PC and open a DOS command window if you are running Windows.

**4** Copy the first firmware image file to DISK_1 using the command "copydisk.exe 64m202_1.img a:".

**NOTE** In step 4 and step 6, we presume your diskette drive is "a:". If not, adjust the copydisk.exe command accordingly.

5 Insert the DISK_2 into your PC and open a DOS command window if you are running Windows.

6 Copy the second firmware image file to DISK_2 using the command "copydisk.exe 64m202_2.img a:".

7 Insert DISK_1 into the mainframe.

8 Turn on the 8164A and wait for the first beep.

Now you must be quick:

- Press and hold the *Preset* hardkey.
- Still holding *Preset*, press and hold the *Aux* hardkey.
- Still holding *Preset* and *Aux*, press and hold the *Appl* hardkey.

**TIP** Use three fingers and place them near the keys in advance!

If you were successful, you here a double beep and the display shows that the instrument is in download mode. Otherwise, turn off the power and try again.

9 Follow the instructions that appear on the screen.

10 Insert Disk_2 when requested to insert the disk containing the file "flash.bin".

11 After the programming finishes, cycle the power. The instrument will reboot with the new firmware. Don't forget to remove DISK_2.

**NOTE** The upgrade procedure above must only be executed with modules that already have firmwave version V0.95 or above. The software will NOT run on firmware s that are lower than V0.95.

## HP 8166A Firmware Upgrade Procedure

To upgrade firmware for the HP 8166A, you require a PC, running MS Windows 95 or NT 4.0, or higher, plus a serial null-modem cable. that was supplied with your HP 8166A mainframe.

Perform the following instructions:

1 Copy the directory Firmware/8166A from the Support Disk to a directory on your PC. This directory contains the files "HPFlashWinR5.exe" and "66_fl202.bin".

2 Click on HPFlashWinR5.exe to start the HPFLASH software.

3 Press the "File Selection" button, the file selection box appears.

4 Move to the file "66_fl202.bin" and click on OK.

5 Click on 'Port Settings'.

6 Select the com port where the serial cable is connected. Choose the maximum baud rate. Click on OK.

7 Turn on the 8166A and wait for the first beep.

Now you must be quick:

- Press and hold the *Preset* hardkey.
- Still holding *Preset*, press and hold the *Aux* hardkey.
- Still holding *Preset* and *Aux*, press and hold the *Appl* hardkey.

**TIP** Use three fingers and place them near the keys in advance!

If you were successful, you here a double beep and the display shows that the instrument is in download mode. Otherwise, turn off the power and try again.

8 Click on 'Program' and wait until the download completes. The instrument will reboot with the new firmware.

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